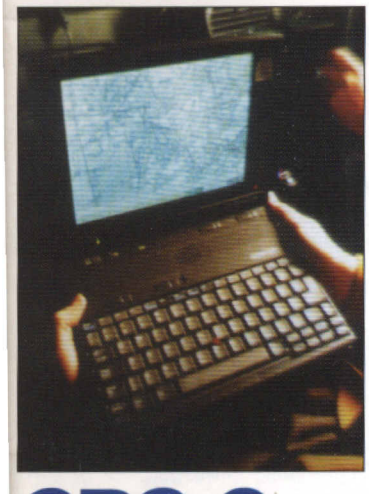
THE MAPLIN MAGAZINE

ELECTRONICS

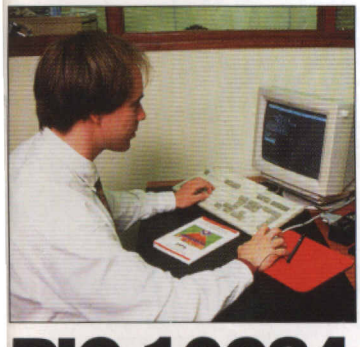
September 1996 No. 105 £2.25

Britain's Brightest Monthly Electronics Magazine

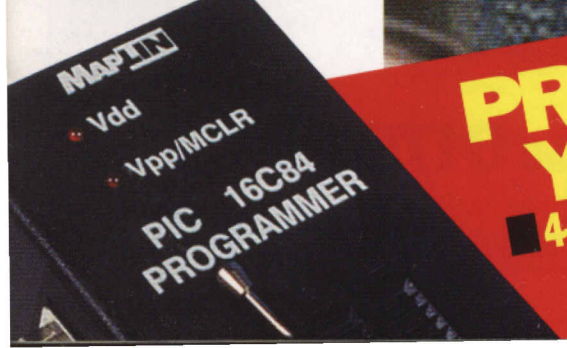
London's Trocadero
The Hi-Tech Experience



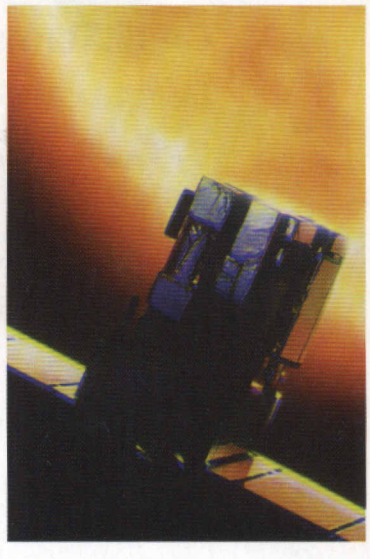
GPS Car Navigation



PIC 16C84 Programmer



SOHO Mission
Observing the sun



09
9 770957 545084

PROJECTS FOR YOU TO MAKE

- 4-10-1 Audio Mixer
- ±15V Regulator
- 3-Channel Sound to Light Unit
- Liquid Level Controller

FREE FAMILY TICKETS

to be won for the London Trocadero.
See page 23.

THE MAPLIN MAGAZINE

ELECTRONICS

September 1996 — Vol. 15 No. 105

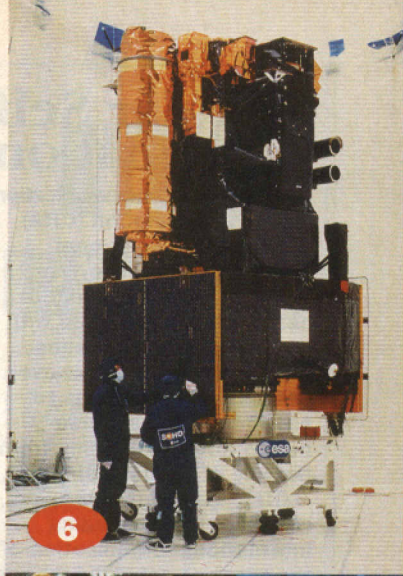
CONTENTS

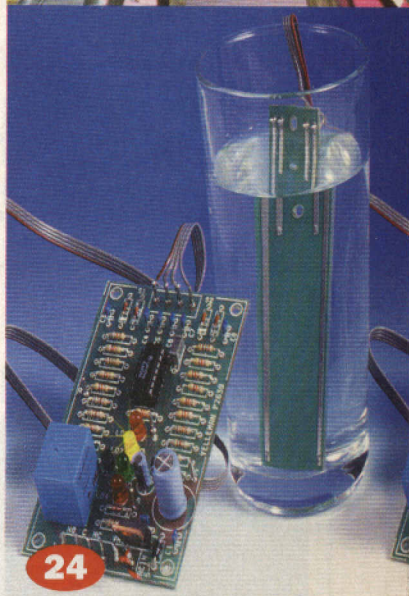
Projects

Features

Regulars

Cover pictures:





Editorial
Editor Robin Hall FBIS, G4DVJ
Technical Author Maurice Hunt BSc (Hons)
Editorial Assistant Lynda Hardy
News Editor Stephen Waddington BEng (Hons)
Drawing Office Ross Nisbet
Technical Illustrators Paul Evans, Kevin Kirwan Dip.Comp.
Project Development Chris Barlow, Alan Williamson

Production
Production Controller Jason Hyatt
Design Layout Artist David Holt
Photography Co-ordinator Peter Blackmore
Photography Librarian Tracy Swann
Published by Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Tel: (01702) 554155. Fax: (01702) 553935.
Lithographic Reproduction by Planagraphic Studios, 18 Sirdar Road, Brook Road Ind. Estate, Rayleigh, Essex SS6 7UY.
Printed by St Ives (Andover) Ltd., West Portway, Andover SP10 3SF.

Management
Manager Paul Freeman-Sear BSc (Hons)
Product Manager Tony Bricknell.

Subscriptions
Maureen Harvey
Tel: (01702) 554155 Ext. 311.

Advertising
Jackson-Rudd & Associates Ltd., 2 Luke Street, London, EC21 4NT. Tel: (0171) 613 0717. Fax: (0171) 613 1108.
Advertisement Manager Eric Richardson.

UK Newstrade Distribution
Seymour, Windsor House, 1270 London Road, Norbury, London SW16 4DH. Tel: +44 (0)181 679 1899. Fax: +44 (0)181 679 8907.

ABC AUDIT BUREAU OF CIRCULATIONS CONSUMER PRESS
Member of the Audit Bureau of Circulations.

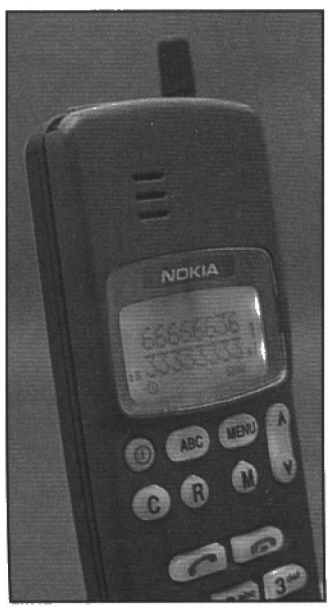
Cellular Self Examination

The Cellular Telecommunication Industry Association (CTIA) will spend an additional $6·7 million in a five-year study, to research alleged health risks associated with the use of mobile phones. CTIA has already spent over $10 million, but claims to have found "no adverse health effects resulting from the use of wireless phones".

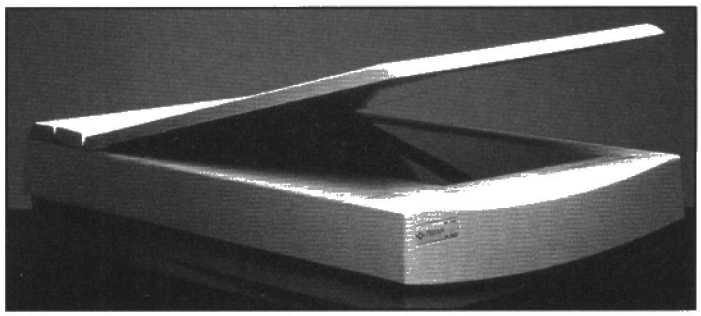
CTIA, formed in 1984, claims to be the leading international organisation of the wireless communications industry. They say that the membership of the association includes all Commercial Mobile Radio Service providers, including cellular, personal communications services, enhanced specialised mobile radio, and mobile satellite services.

But surely, there is a conflict of interest here – an industry body investigating harmful health effects of its own technology? The CITA reckon not. A spokesperson for the organisation told *Electronics*, "The research program funded by the wireless industry is unique, in that it contains a series of firewalls that insulate the scientific research from industry influence." Really?

Meanwhile, the World Health Organisation (WHO) has announced a $3 million five-year project to investigate the effects of microwave radiation, including electrical and magnetic fields generated by mobile phones. The five-year project will look at the health and environmental effects of exposure to static and time-varying electric and magnetic fields with frequencies 0 zero to 300GHz.



NEWS REPORT



Scanned Images

The OpticPro 4800P A4 Flatbed scanner from Plustek has a maximum resolution of 4,800 × 4,800dpi at a colour depth of 24 bits per pixel and comes with image and OCR software and the Fax-Copy utility, Action Manager.

The OpticPro 4800P is supplied with a parallel port connector and carries a recommended retail price of £199.00.

Contact: Plustek, Tel: (0345) 400300.

IBM Backs Infrared as Mobile Communication Standard

IBM has announced three infrared communications chips that can send and receive at 4M-bps. The chips operate at the fastest speed currently available for products compatible with standards set by the Infrared Data Association (IrDA). In addition to an infrared controller chip, which functions as a dedicated processor, two versions of a transceiver chip, capable of both transmitting and receiving infrared signals, IBM is also making software available. They are the industry's first combined infrared hardware and software solution for original equipment makers (OEMs) to develop products that are compatible with IrDA standards. The use of infrared signals to replace bulky cards or wires for digital communications between computers, networks, or other machines, is expected to grow. According to US analysts GIGA Information Group, all notebooks and sub notebooks will be equipped with infrared technology by 1997.

For further details, check: **http://www.chips.ibm.com/products**.

Contact: IBM, Tel: (+33) 1 49 05 85 08.

Elonex 200MHz Pentium

Almost immediately that Intel announced its 200MHz Pentium, direct sales PC manufacturer, Elonex, declared that it is ready to ship a variety of PCs powered with Intel's latest hot chip. Elonex's 200MHz based C-5200/I and MT-5200/I computers are supplied with 8M-byte EDO RAM – expandable to 128M-byte.

Other standard features include a 540M-byte IDE hard disk with optional capacities ranging up to 4·0G-byte SCSI; a 64-bit PCI graphics accelerator with 1M-byte DRAM (2M-byte DRAM, 2M-byte VRAM and 4M-byte VRAM options); a 14in. non-interlaced at 1,024 × 768 pixel colour monitor; a 105-key UK Windows '95 keyboard; a Microsoft mouse; and two high speed RS-232 16550A serial ports. Prices start at £1,500.

For further details, check: `http://www.elonex.co.uk`. **Contact: Elonex, Tel: (0181) 452 4444.**

Cheaper Weekend Calls to Mobiles

It used to be the case that calls to and from a mobile phone were charged a premium rate. But now, BT has made a concession for weekend calls – see table below. Calls made to the Cellnet or Vodaphone networks from midnight Friday to midnight Sunday will cost 12·5 pence per minute, down from 28·32 pence. BT plans to make additional cuts in the Autumn for calls made to mobiles during the week.

	Daytime Mon to Fri 8am to 6pm	**Evening** Mon to Fri 6pm to 8am	**Weekend** Midnight Fri to Midnight Sun
Cost per minute	41·05p	28·32p	12·5p
Cost per 5 minute call	205·20p	141·60p	62·5p

Demo Download

Symantec is offering a 30-day online trial of pcAnywhere 32, the latest version of its remote communications package. It is also offering a £59 upgrade to users of LapLink, Carbon Copy and Reach Out. The price includes a parallel cable to transfer data between PCs.

For further details, check: **http://www.symantec.com**.

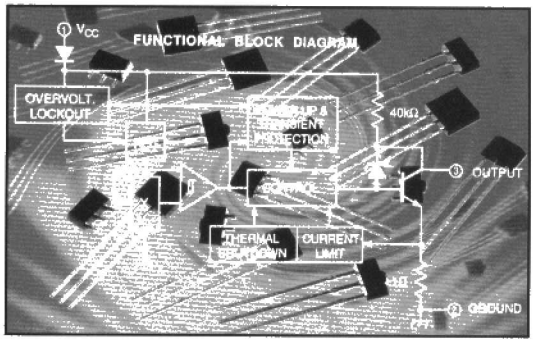
Contact: Symantec, Tel: (01628) 592222.

Rotational Measurement

The A3197LU from Allegro is a fully protected open collector Hall-effect latch IC, rated for operation over the temperature range –40°C to +150°C. The device is targeted at angular measurement applications in crude operating environments.

The A3197LU provides position and speed information by generating a digital output when the magnetic field exceeds its predefined switch points.

Contact: Allegro, Tel: (01932) 253 355.



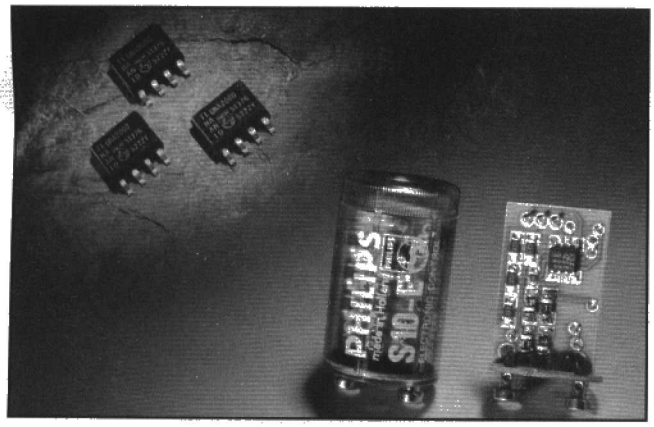
Flashing Strip Light Cure

A fluorescent strip light that constantly flashes, either because the tube or its starter has failed, can be very annoying. Even worse, it can cause headaches and nausea. Philips Semiconductors has now solved the problem. The UBA 2000T Electronic TL-Lamp Starter IC provides optimal ignition conditions for working tubes and prevents wasted attempts to re-light dead tubes. To ensure 100% compatibility with existing lighting equipment, the UBA2000T and all its associated components can be fitted within a standard glow-switch starter casing.

By counting AC line supply cycles after the strip light is turned on, the UBA2000T generates a precisely defined electrode pre-heat period of 1·52s for 50Hz supplies or 1·27s for 60Hz supplies. During this period of time, it turns an external thyristor or MOSFET on to allow pre-heat current to flow through the tube's electrodes. After the pre-heat period has elapsed, the external switching device is turned off at a guaranteed level. This ensures that sufficient striking voltage is generated by the inductive lighting ballast to instantly ignite the fluorescent tube.

In the unlikely event that the tube doesn't ignite first time, a reduced pre-heat time of 0·64s (50Hz supply) or 0·53s (60Hz supply) is applied and a second attempt is made at ignition. If after seven attempts, the tube has still not ignited, the UBA2000T is latched into its off-state and no further attempts are made to ignite the tube until the device is reset by turning the AC line supply off and on again.

For further details, check: **http://www.philips.com**.
Contact: Philips, Tel: (+31) 40 272 20 91.



Consumer Electronics Giants Converge on Sun's Java Chips

LG Semicon, Mitsubishi, NEC, and Samsung have signed up to Sun's JAVA Chips technology. Each of the four companies intends to develop products based on Sun's picoJAVA microprocessor core.

The Java Chips family consists of the microJAVA and UltraJAVA microprocessor family The picoJAVA core directly executes the Java instruction set in silicon. Unlike traditional CISC and RISC processors, it eliminates the need for interpretation of the Java instruction set and the associated system downsides of interpretation – high cost, memory-intensive system design and performance degradation. The first products based on Java Chips technology are expected in late 1997. For further details, check: http://www.sun.com. Contact: Sun, Tel: (01276) 20444.

Surf at Savacentre

Next time you pop down the supermarket, you'll be able to pop a modem in your shopping trolley along with your tea and coffee.

Savacentre, the Sainsburys Hypermarket, is now selling Hayes modems in seven of its stores throughout the country. The stores, based at Calcot near Reading, Hempstead near Gillingham, London Colney, Merton, Sydenham, Sheffield and Stockton-on-Tees, stock the Hayes ACCURA 288 v.34 Internet Kit.

The Kit comprises Internet software for Windows, one month free trial connection time to Premier Internet and CompuServe, Hayes Introductory Guide to the Internet and 50% discount offer on Net Nanny software.

This is in addition to the ACCURA 288 v.34 + FAX, Hayes Smartcom for Windows LE modem software, Hayes Smartcom FAX for Windows software, a serial cable to connect the fax modem to the PC and a dual telephone adaptor, which are included with the ACCURA range of modems as standard. For further details, check: **http://www.hayes.com**.

Contact: Hayes, Tel: (01252) 775555.

Motorola launch New 16-bit Architecture

Motorola has launched the 16-bit 68HC12 (HC12) microcontroller (MCU) architecture. The enhanced, general-purpose architecture offers a combination of low power consumption and low voltage operation.

An enhanced version of the HC11, the HC12 incorporates a number of new high-performance and user-friendly features, along with a rich super set of popular HC11 instructions. The core elements of the HC12 architecture are the enhanced, 16-bit core (CPU12) and a sophisticated, modular design that allows flexible integration of a variety of on-chip peripherals.

For further details, check: **http://www.motorola.com**.

Contact: Motorola, Tel: (01753) 575555.

NEWS BYTES

City Moves Towards Electronic Recycling

An estimated 3,000 tonnes of electrical and electronic equipment are disposed of in the City of London each year – including more than 2,000 tonnes of PCs and printers, and 500 tonnes of photocopiers.

The City's local authority, the corporation of London, has carried out a survey measuring the potential for a recycling service to tackle this waste stream, and is now pressing forward to determine the precise requirements and costs of a service which could be the catalyst for a whole new industry in London.

Planning chairman, Barbara Newman, told *Electronics*, "What we envisage is a new recycling plant that provides jobs for Londoners as well as huge environmental and economic benefits. For the scheme to succeed, we must work closely with the City community. We now want to consult major potential users to get the ball rolling quickly."

Contact: Corporation of London, Tel: (0171) 606 3030.

Channel 5 Teletext

The Independent Television Commission (ITC) is inviting applications for a single license to provide a teletext service over the spare bandwidth capacity of Channel 5. Applicants are free to propose any mix of open access or closed subscription use.

Contact: ITC, Tel: (0171) 255 3000.

Communications Freedom

Portable Add-ons has introduced the FreeSpirit PC Card modem, a v.34 PCMCIA fax/modem which enables connection either through a telephone land-line, or wirelessly via a digital mobile phone and GSM network.

Contact: Portable Add-ons, Tel: (01483) 241333.

Lost File Retrieval

Current trends towards increased amounts of storage space on the desktop or portable PC leave many users feeling frustrated, purely by the ever growing number of files. To find lost files accidentally dropped in the wrong place can sometimes take an age.

Now, Turbo Browser for Windows 95/NT 4.0 from the Thompson Partnership offers an easier and integrated way to safely manage applications and data anywhere on your computer and network. The applications enables files to be located anywhere on your computer or network by contents or by attributes, including a fuzzy search function and boolean features. An evaluation version of Turbo Browser is available from ftp://ftp.ttp.co.uk.

Contact: The Thompson Partnership, Tel: (01889) 564601.

NEWS BYTES

Digital Tapeless Studio

Ask any musician, songwriter or record producer for their recording requirements and it would have to include a digital recording studio. And in an ideal world, that studio would combine the advanced editing functions of a digital audio workstation with the affordability of a personal multitracker. All a pipe dream? Then read on.

The Yamaha MD4 is the first available multitrack recorder based on the optical Mini Disc format.

In addition to the digital four track recorder, the MD4 includes a mixer and editor sections for the price of £899 including VAT. This sort of price tag makes affordable for musicians across the world.

Mini Disc combines digital sound quality with low cost, instant access to tracks and almost endless track bouncing. No more unwanted pitch flutter or tape hiss.

Unlike hard disk, Mini Disc is removable, so starting a new project becomes very easy.

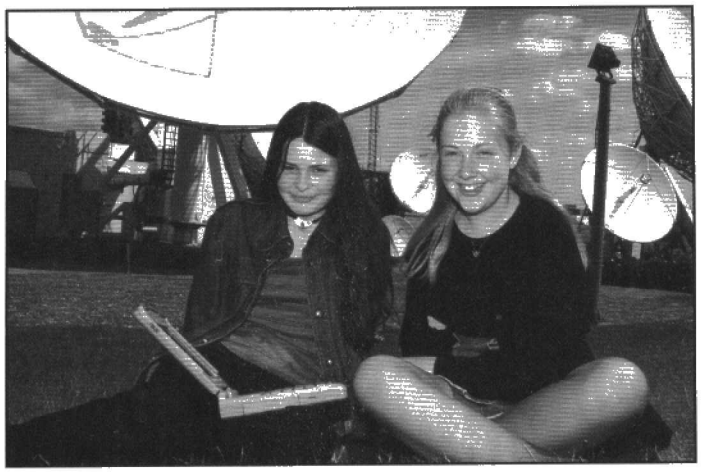
There is virtually no degradation in audio quality because the Mini Disc format is digital, there is virtually no degradation in the audio quality, no matter how many times the tracks are bounced together. Just as importantly, Yamaha has given the MD4 the ability to play all four tracks, while recording back onto one of the tracks.

Yamaha has given the MD4 fast transport functions for search and locate, as well as four track simultaneous record and playback capability. With all four tracks full, the Mini Disc still allows as much as 37 minutes of continuous music. (Total mono recording time is 148 minutes.)

As there is no tape, so there are no rewind times. Powerful 'combine and divide' functions make almost 'impossible' edit manipulation fast and easy. The Auto Punch In/Out has an accuracy of 11·6ms.

The integral mixer section of the Yamaha MD4 is analogue and offers gain, three band equalisation, aux send for effects, pan and fader. On the output side, it has four groups, stereo out, monitor out and other useful facilities including direct outs. The aux return is stereo. The MD4 is also equipped with MTC output for synchronising external MIDI sequencers.

Contact: Yamaha-Kemble, Tel: (01908) 369269.



Holly Breaks 10-year Silence

Thirteen year old Holly Potter has been given a new voice thanks to BT technology. Holly, daughter of a BT engineer from York, lost her voice through medical complications following a severe attack of croup at the age of three. She now uses a lap top computer programme developed by BT Laboratories which converts to speech any text stored or keyed in by Holly.

Unlike other 'computer voices', which are machine generated and completely artificial, the BT system reproduces real human speech using the components of recorded human language. The voice is realistic and even includes proper punctuation, phraseology and inflections.

The original recording can be of anyone, and the resulting voice is recognisably theirs. The computer analyses the thousands of components of the recording and when words are typed in, the right components are selected and reassembled into the appropriate words.

A voice recording made before a person loses their natural speech can thus can be stored, to be given back later on by a text-to-speech computer.

In Holly's case, her new voice was recorded by Charlotte, the daughter of Dr Andy Breen who led the team of BT scientists responsible for the development.

Dr Breen said that when BT started this project they were thinking of applications like having your E-mail read out to you over the telephone. As it progressed further it became clear that it would be a boon for people with speech difficulties. As Holly grows the speech will be updated with 'older voices'. The BT system is known as Laureate and BT is currently negotiating a licencing agreement with an outsider organisation, who are to make the system available to the general public and speech impaired groups.

Contact: Nick Gordon-Brown, Tel: (0171) 729 6088, Fax: (0171) 739 5436.

CRL Launches New Spatial Light Modulator

Central Research Laboratories has launched a new spatial light modulator (SLM), the VGA1, which is a simple high resolution, black and white SLM.

Based on a thin film transistor (TFT) twisted nematic liquid crystal display, the VGA1 is designed for use as the input device in optical processing systems, helmet-mounted displays, miniature displays, low power marking systems and other applications requiring a compact high resolution device.

Extending the range of SLMs developed by CRL, VGA1 provides greyscale capability at standard video frame rates and features 640 × 480 VGA resolution with a poly-silicon TFT active matrix. The device is very compact, measuring 34mm on the diagonal, and has a PC VGA monitor interface.

Available directly from CRL or through its distributors, the VGA1 device can be supplied as a kit of parts containing an active device, interface and power supply or as a housed device complete with interface and power supply.

Dr. Lewis Banks, group manager for CRL's Smectic Technology Group commented: "Previously, if someone wanted a device such as this, they would have to buy an expensive projector and reverse engineer it. The VGA1 makes us the only UK supplier of such a low-cost, high resolution device.

Contact: CRL, Tel: (0181) 848 6444/6661.
Fax: (0181) 848 6682/6565.

Sony Introduces New GSM Handyphone

Sony has announced the introduction of a new compact GSM Handyphone, CMD-Z1, equipped with an innovative 'jog-dial' that allows the user to scan and select the desired function by using one finger. This will be the second Sony GSM mobile phone to benefit from having a Lithium Ion battery as standard.

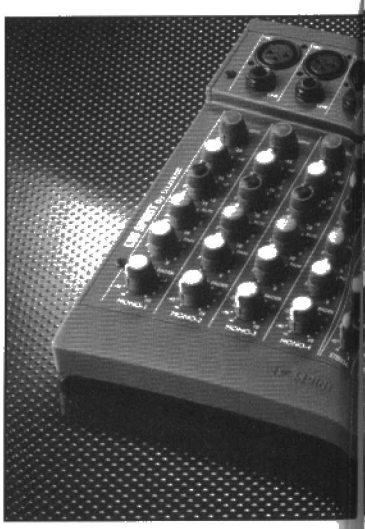
This newly designed jog dial is based on a new Man-Machine Interface (MMI) concept. Instead of pushing various buttons, the user simply 'thumbs' through the menu that appears on a large back-lit LCD by rotating the scan and select dial with one finger. By pressing the dial once, the user can scan and select the desired function. A second push will activate the function. The rotate and push design of the jog dial, combined with a large LCD display, enables flawless and easy operation of the CMD-Z1 with one hand.

Sony's expertise in multi-layer, high-density circuit board technology contributed to the compact size of the CMD-ZI. It can, for example, slip into a shin pocket or handbag for true portability. The lightweight, high energy Lithium Ion battery, pioneered by Sony, offers an unprecedented 80 hours standby or three hours continuous talk time.

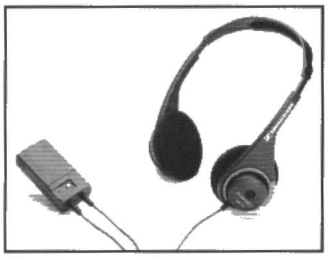
Sony's other GSM mobile phone (CM-DX1000) was the first GSM mobile phone to have Lithium Ion as standard.

The CMD-ZI will be introduced in to the UK in the Autumn of 1996.

Contact: Sony UK, Tel: (01932) 816000.



NEWS BYTES



Air France Cut Aircraft Noise Levels

In the never ending quest for greater passenger comfort, Air France has recently began to use Sennheiser NoiseGardTM headphones, to provide a superior performance in-flight entertainment system.

The in-flight headset, not only provides Hi-Fi sound reproduction, but also actively attenuates the aircraft cabin noise, allowing the passenger to enjoy music or in-flight movie soundtrack at a lower ambient noise level than that experienced when not wearing the headset.

Aircraft cabin noise, caused by engines and slipstream, is not only a serious problem for the pilot but also for passengers, especially on long-haul flights in large jet aircraft, the noise level during normal flight can be as high as 80dB(A). This noise pollution causes stress, the passengers cannot readily sleep or follow in-flight entertainment system soundtrack dialogue or music, at sensible listening levels.

In the early 90's, Sennheiser found a solution to the ambient noise problem and launched their NoiseGardTM headphone. This lightweight headphone features special electronic circuitry which effectively reduces the disturbing low frequency noise by approx. 10dB, ie. half.

Moreover the noise attenuation system does not impede normal conversation, as speech consists of higher frequencies than those cancelled out. Communication with other passengers or cabin crew actually becomes easier, since the background noise is reduced.

Contact: Sennheiser UK Ltd., Tel: (01494) 551551.

Compact Nearfield Monitor System

Resplendent with brilliant red drivers, Spirit's new Absolute Zero is a compact nearfield monitor that performs and sounds like a large studio monitor system.

As with the Absolute 2, the drivers of the Absolute Zero are designed to get maximum performance from the cabinet size; Absolute Zero's woofer features a deep 30mm voice coil coupled to a cone whilst its suspension is carefully optimised to get high levels of low frequency sound out of a small enclosure and a large diameter port. Using these techniques bass response remains unrestricted even at the high listening levels required by the professional.

Absolute Zero's Tweeter is a soft-dome unit driven by a 25mm ferrofluid cooled voice coil mounted on a specially shaped wave guide. This leads to increased power handling and controlled dispersion of high frequency sounds, ensuring you hear more of your music and less of your room.

With a crossover network optimised using the latest CAD techniques to take advantage of the acoustic alignment of the drivers and high quality components used throughout, the low distortion of the drivers is never compromised.

Contact: Spirit by Soundcraft, Tel: (01707) 665 000.

Folio Notepad

Better things now come in even smaller packages. Spirit's Folio Notepad redefines the look and performance of the mini mixer; cute, curvy and very clever.

Folio Notepad will be the smallest and most affordable mixer in the Spirit Folio range, yet despite its small size it more than meets Spirit requirements for professional sound quality and features.

Notepad achieves DAT-quality audio as a result of its surface-mount design and components common to the larger Spirit consoles. Even at this price, Notepad is equipped with quality microphone preamps that take up to l6dBu of input level and an impressive EIN figure. High RF rejection to EC standards ensures clean, noise-free mixes.

Notepad is a versatile mixer that you can take anywhere, from live gigs to studios.

Contact: Spirit by Soundcraft, Tel: (01707) 665 000.

Virtual Reality Unveiled by BT

BT Laboratories has developed technology which allows people to walk around inside virtual worlds created by computers and transmitted down telephone lines.

The advance has been made possible by the VisionDome in which up to 15 viewers at a time are surrounded by projected virtual world images. The dome gives a full colour 360 × 180° hemispherical field of view, with spatialised sound, in which 3-D is experienced without the need for glasses or goggles. Images which can be projected include computer graphics, virtual landscapes, data graphics, video and even live action.

BT is using the dome as part of its 'Shared Spaces' and media environment research programme, which is exploring how virtual environments can enable group interaction around common data, shared applications and telepresence. But it is the highly realistic feeling of inhabiting virtual worlds that has excited the BT scientists.

Graham Walker, who is leading the BT research said: "flat computer screens have been useful, but they have their limitations. With VisionDome technology we can foresee the time when, for example, architects and their customers could walk round and inside buildings not yet erected; chemists might explore molecular models from the inside; engineers could share distributed CAD modelling, and even financiers might one day be able to crawl over the figures for real!"

The need to be able to assimilate ever-increasing volumes of complex data, in both science and business, is driving BT's leading-edge research into data visualisation using virtual reality. The research also includes work on audio and non-spatial data, and BT service and network implications.

Graham Walker continued: "We are looking at high level data interfaces and customer applications. The VisionDome is a new and exciting environment, and we have enjoyed a very fruitful collaboration with Alternate Realities Corporation in the US which is responsible for the hardware. At BT we are combining their technology with our expertise in virtual reality techniques for information management, and we have now achieved the experience of being actually inside the data – the results are quite spectacular."

The enormous promise of the work is emerging rapidly, and BT is beginning to evaluate this new dimension in immersive technology. Future work is expected to concentrate on potential networked applications.

Contact: Nick Gordon-Brown, Tel: (0171) 729 6088.

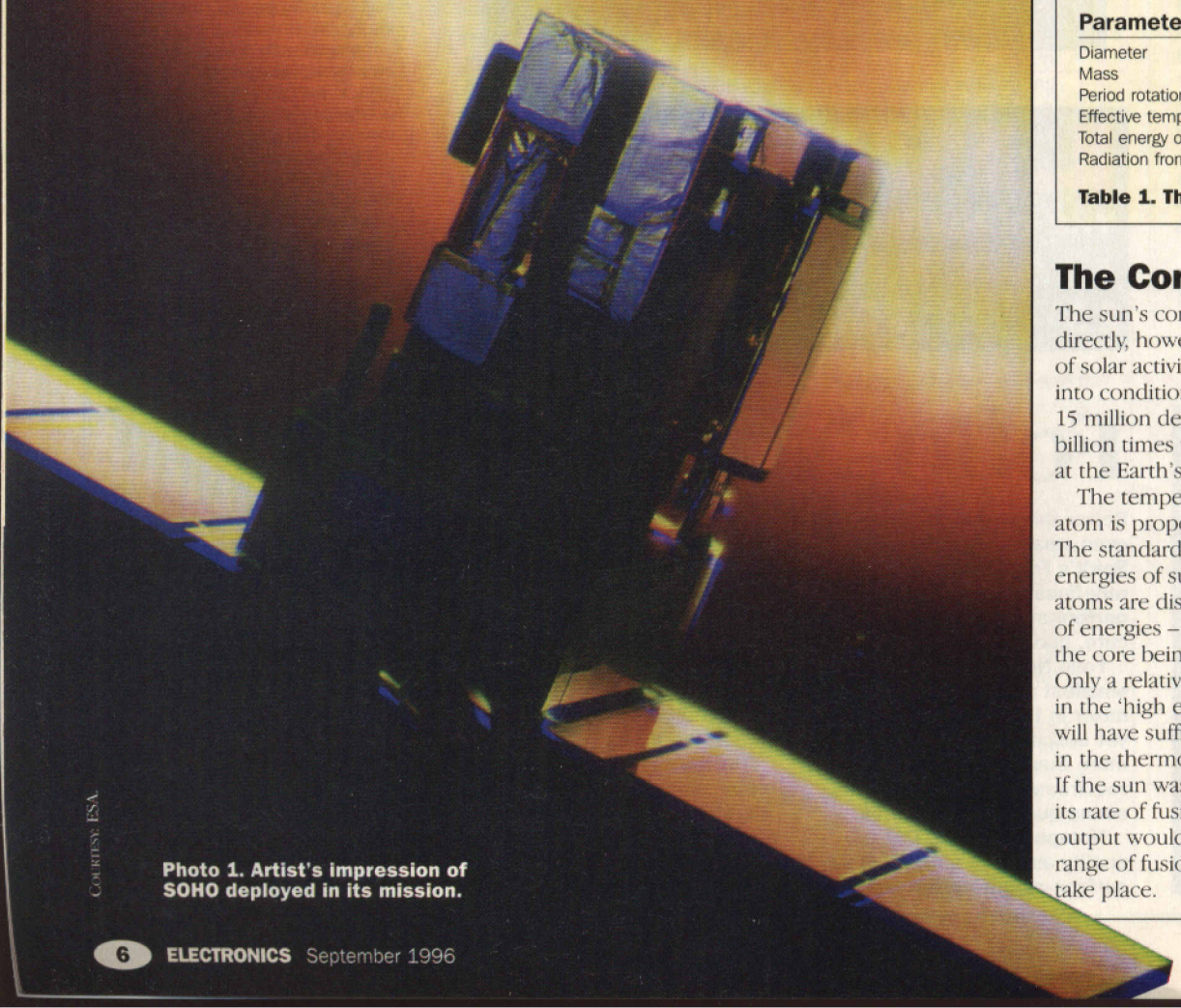
Brighton Store

Please note that the Maplin store in Brighton will no longer be open on Sundays from 11th August.

Sun Gazing: THE SOHO MISSION

by Douglas Clarkson

While several previous space missions have observed the sun, the current SOHO (SOlar and Heliospheric Observatory) mission of the European Space Agency/NASA represents a quantum leap in observing function, and will significantly improve the understanding of our nearest star. As part of the Solar Terrestrial Programme comprising SOHO and CLUSTER, SOHO comprises nine European Principal Investigations and three American ones.



COURTESY ESA.

Photo 1. Artist's impression of SOHO deployed in its mission.

The achievement of the SOHO mission underlines the value of international scientific co-operation. With design studies of SOHO dating from around 1984, the main development work commenced only in May of 1991. While the design of SOHO and the fabrication of its diverse instrument systems has been largely a European initiative, use has been made of NASA's superior launch vehicles and deep space tracking system, to control and retrieve data from the craft.

Photo 1 indicates an artist's impression of SOHO, launched successfully on 2nd December 1995 at Cape Canaveral by an Atlas IIAS rocket. While SOHO was not the heaviest ESA/NASA payload, its mass at launch of 1,610kg plus 240kg of propellant included a highly sophisticated scientific payload of 650kg.

SOHO will carry a total of twelve sophisticated telescopes and other instruments, developed by twelve international scientific consortia and involving scientific groups in 15 countries. While even specific single instruments of SOHO in themselves would be a major advance, the combination of systems adds even greater significance to the mission.

The Nature of the Sun

SOHO will obtain information about all aspects of the sun's structure. A brief summary of the various regions of the sun is included here for reference. The structure and features of the sun are summarised in Photo 2, while aspects of its 'vital statistics' are presented in Table 1.

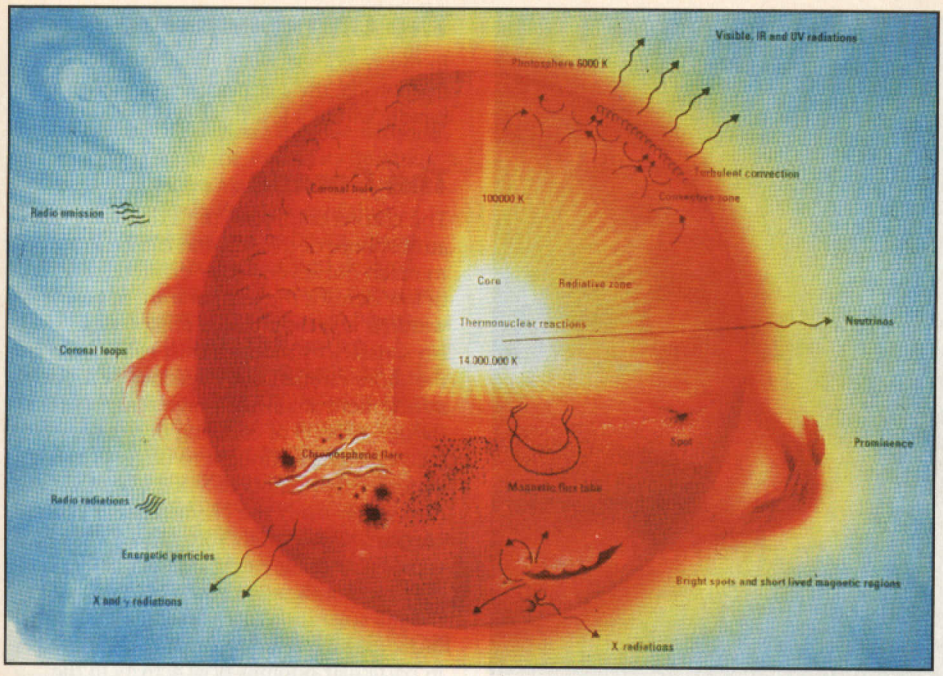
Parameter	Value
Diameter	1,392,000km
Mass	$1{\cdot}99 \times 1{,}030$kg
Period rotation (equator)	26·9 days
Effective temperature	5,740K
Total energy output	$3{\cdot}86 \times 10^{26}$W
Radiation from surface of sun	6·35kW/cm^2

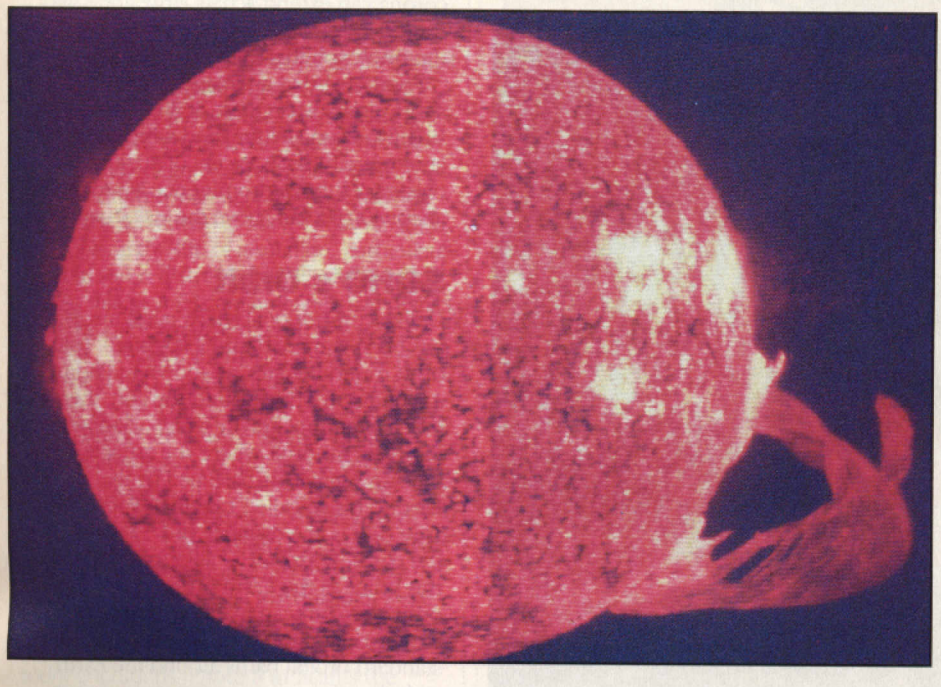
Table 1. The Sun's vital statistics

The Core

The sun's core cannot be investigated directly, however, numerous indicators of solar activity may provide new insights into conditions where a temperature of 15 million degrees and a pressure 300 billion times the atmospheric pressure at the Earth's surface are thought to exist.

The temperature of the hydrogen atom is proportional to its kinetic energy. The standard Boltzmann distribution of energies of such particles ensures that atoms are distributed over a wide range of energies – with the average energy in the core being around 15 million degrees. Only a relatively small number of atoms – in the 'high energy tail' of the distribution will have sufficient energy to take part in the thermonuclear fusion processes. If the sun was much hotter at the core, its rate of fusion and hence its energy output would be greater, since a broader range of fusion reactions could then take place.





prevailing. Solar neutrinos generated during the fusion reactions interact very weakly with matter and the majority pass through the sun's structure and proceed outwards to fill the solar system with their invisible presence.

The Convection Zone

With the density of solar material progressively decreasing towards the photosphere, the radiation is able to break free from the depths of the sun. Also, the considerable temperature gradients between the surface of the photosphere (around 6,000K) and the top of the radiation zone (around 2×10^6K) gives rise to colossal convective processes involving hot gases.

The Photosphere

The photosphere is the visible 'surface' of the sun. Being only some 500km deep, it is characterised by cells of convection, with each cell being approximately 50,000km in size.

Sunspots are identified as regions of cooler gas which appear darker. One of the main cycles of the sun is its sunspot cycle, which on average, is completed each eleven years. There is however, considerable variation in the length of such cycles. While all the planets parade around the sun with clockwork precision, the sun itself has an element of randomness and even chaos to its own internal processes. The development of sunspots is considered to be related to the cyclic variation of the local magnetic field at the sun's surface.

Above left: Photo 2. Structure and features of the Sun.

Left: Photo 4. Image obtained in the short ultraviolet at 30·4nm from singly ionised Helium and which develops at temperatures in excess of 80,000K. Clearly visible is a twisting eruptive prominence arching about 400,000km avove the visible solar disk.

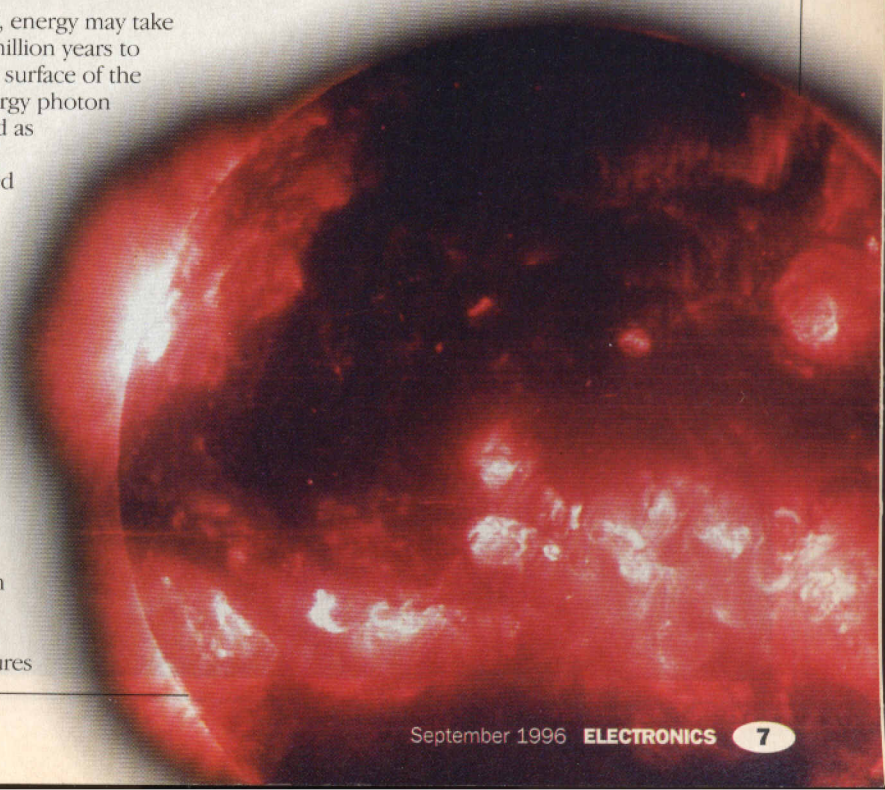
Below: Photo 3. Details of a soft X-ray image of the full solar disk taken during a rocket flight on 11th September, 1989.

PHOTOS 2 & 3 COURTESY: ESA. PHOTO 4 COURTESY: LEON GOLUB, SMITHSONIAN ASTROPHYSICAL OBSERVATORY.

Many of the changes taking place in the sun can be described as long term. The fusion of hydrogen nuclei to Helium nuclei reduces the number of particles, maintaining the 'gas pressure' within the core. As particles are effectively removed, the size of the core will steadily reduce, but at a barely perceptible rate. This will encourage the release of energy from gravitational collapse, which in turn, will tend to increase the radiation rate and heat the outer layers and expand them. It is considered, however, that the sun has maintained its energy output at a remarkably constant rate over periods of hundreds of millions of years.

The Radiation Zone

While light takes about eight minutes to travel from the outer surface of the sun to our planet, energetic photons released deep in the sun's core take much longer to reach across the two million kilometre distance across the radiation zone. Theorists estimate that on average, energy may take as long as ten million years to reach the outer surface of the sun. A high energy photon can be imagined as being absorbed then re-absorbed countless times by energetic atoms, with path travel being totally random and chaotic. One of the key determinants in this estimation is the very low value of mean free path of photons between interactions, caused by the ultra high pressures



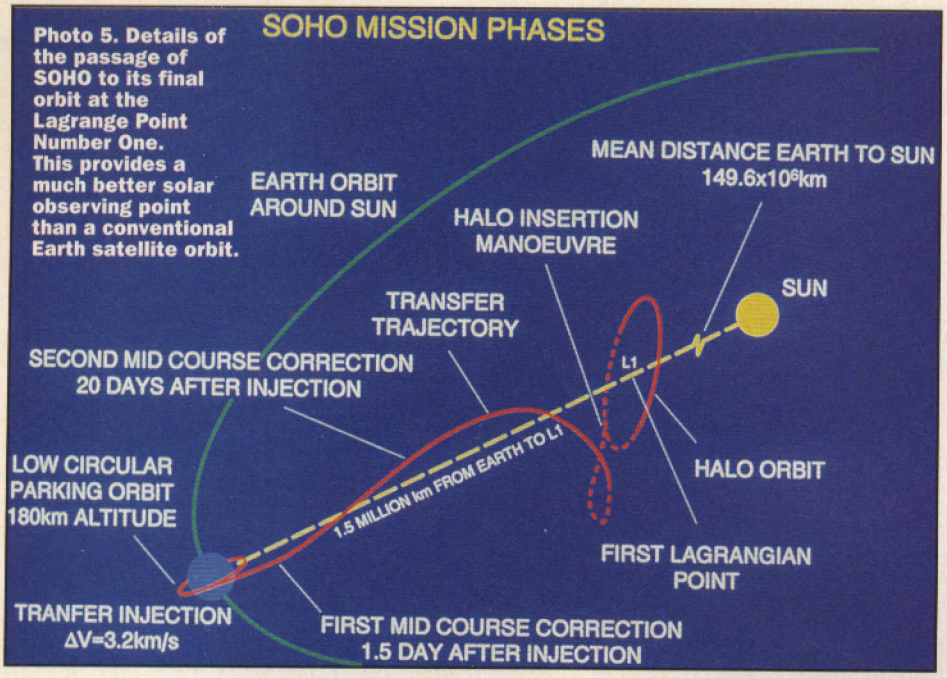


Photo 5. Details of the passage of SOHO to its final orbit at the Lagrange Point Number One. This provides a much better solar observing point than a conventional Earth satellite orbit.

COURTESY: GUENTER E. BRUECKNER, NAVAL RESEARCH LABORATORY.

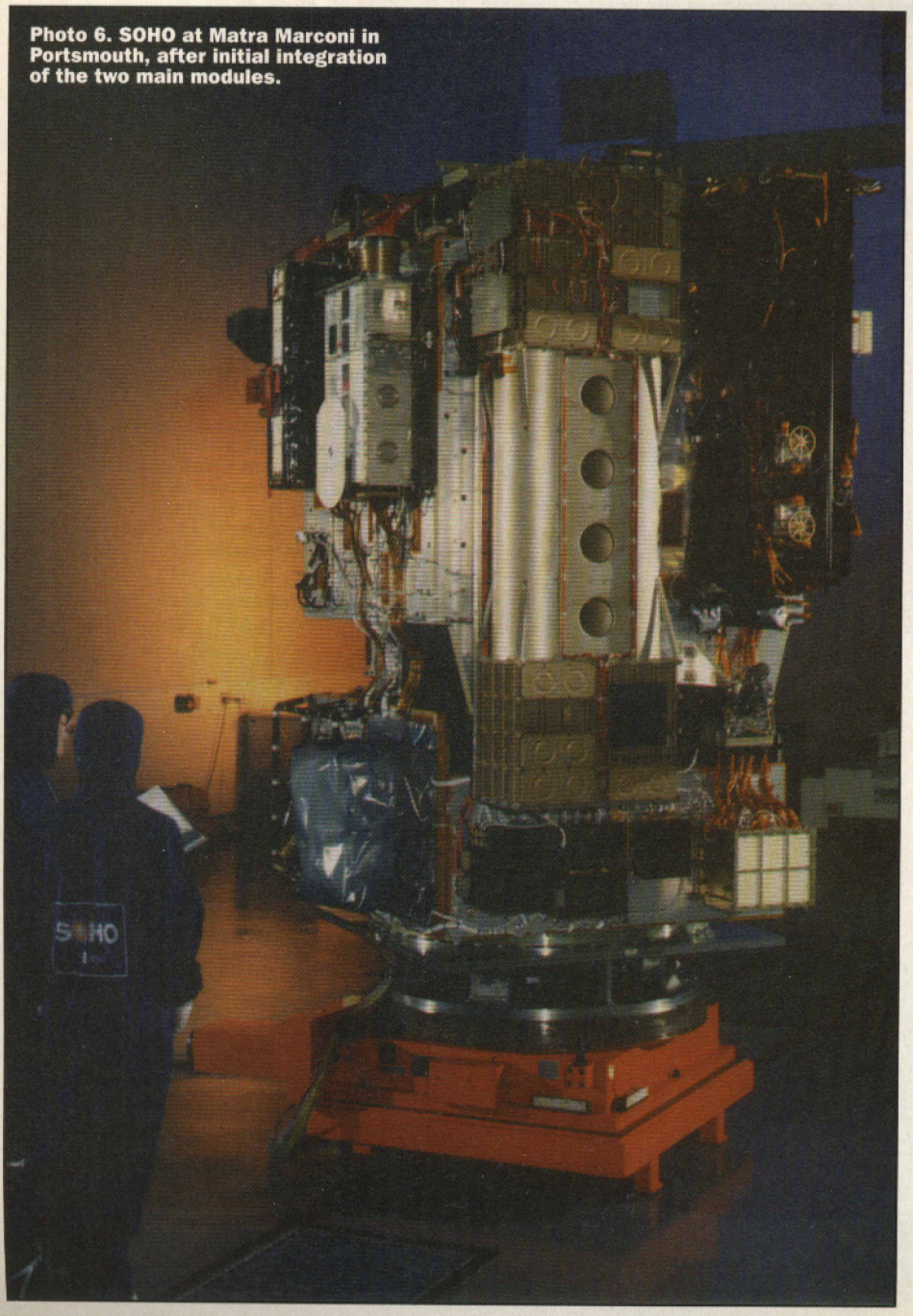


Photo 6. SOHO at Matra Marconi in Portsmouth, after initial integration of the two main modules.

COURTESY: ESA.

The Chromosphere

In this region between the photosphere and the corona, the temperature of the gas rises rapidly within a few thousand kilometres.

The Corona

The corona comprises the extended outer atmosphere of the sun and can be imagined to reach out several solar diameters. While of low density, the temperature of gases within it is greater than a million degrees. No satisfactory theories exist to explain how the more rarefied outer reaches of the sun's atmosphere attain such high temperatures, though aspects of coupling of magnetic field energy are thought to be responsible. Various experiments of SOHO, however, will extensively study the characteristics of the corona and hopefully solve an aspect which is probably the greatest mystery of the sun.

Photo 3 indicates a soft X-ray image of the full solar disk taken during a rocket flight on 11th September, 1989. The image in particular outlines how activity in the corona can extend across large areas and extend for considerable distances above the photosphere.

Photo 4 shows an image obtained in the short ultraviolet region, at 30·4nm from singly ionised Helium, and which develops at temperatures in excess of 80,000K. A twisting eruptive prominence is seen to arch about 400,000km above the visible solar disk.

SOHO's Orbit

Unlike conventional space missions, SOHO has been launched into a so-called 'halo' orbit round the sun, as shown in Photo 5. As the Earth orbits round the sun, there is a point of neutral gravity which shadows the Earth's solar orbit where the attraction of the sun's gravity is balanced by that of the Earth. This so-called Lagrange Point Number One (L1) is at a distance of $1{\cdot}5\times10^{6}$km from the earth. With SOHO able to loop around this point as the Earth proceeds in its orbit, the craft can maintain continuous monitoring of the sun – in contrast to standard orbital paths around the Earth with their frequent sunsets and sunrises.

In the Lagrangian point halo orbit, the orbital path of SOHO will have a radius of approximately 600,000km – allowing it to experience perpetual day.

A precise system of orientation control, which comprises a fine-pointing sun sensor and a separate star tracking system, allows the satellite to maintain its stability to a few ten-thousandths of a degree. Any necessary changes are made by means of control of three reaction wheels. This is an advancement on systems requiring small impulses from miniature rocket jets, which have a limited supply of fuel.

General Design

The design of SOHO comprises two main modules – the payload module which houses the scientific experiments and the service module, which distributes power from the solar panels, provides thermal control, pointing and communications for the spacecraft.

These separate modules were fabricated by separate divisions of Matra Marconi in Portsmouth, UK and Toulouse, France, and integrated during August 1994. Photo 6 shows the SOHO payload module without thermal blankets at the end of its integration and testing at Matra Marconi in Portsmouth. The performance specification of the various experiments had to be improved in order to achieve the required design criteria. This placed considerable pressure on the various experiment design teams.

In a system such as SOHO with a multiplicity of modules, a vital phase of the proving of the craft was the measurement of microvibrations from any moving parts, in order to ensure that neighbouring experiments were not adversely affected by mechanical jitter. Photo 7 indicates SOHO in its launch configuration with folded solar panels about to undergo acoustic tests at Toulouse.

Minimising Contamination

Experience of previous solar observing missions has indicated that system degradation can occur due to particulate contamination of satellite surfaces. Individual dust grains can act as scattering points for light and other radiations. Traces of organic materials can form films on optical surfaces that severely degrade performance. In particular, ultraviolet sensors tend to show significant sensitivity to such contamination. Also, during the life of a satellite, particulate material can redistribute itself around the craft so that general contamination can detract from the performance of critical systems.

Great care was, therefore, taken at every stage of SOHO's construction to minimise the levels of such particulate contamination. Many components were 'baked' under vacuum conditions in order to drive off volatile materials that could have been released under the extreme environment of outer space. Clean room techniques used by chip fabrication industries were used wherever possible. Most instruments were designed with well-sealed door/aperture systems that were only opened in clean room conditions. Photo 8 indicates the face of SOHO that houses instruments that monitor the sun directly.

Test areas were generally kept at higher atmospheric pressure to exclude ingress of dust-laden air during exit/entry to the facility. Levels of contamination were monitored by devices which included quartz crystals, whose resonant frequencies altered when they picked up surface contamination.

Ground Control

SOHO is controlled from NASA's Goddard Space Flight Center in Maryland, USA, with data retrieved by means of the NASA Deep Space Network installations at Goldstone, Canberra and Madrid. Photo 9 shows one of the large antennae of the Deep Space Network. SOHO's set of experiments will generate a continuous stream of data at 200k-bps.

Signals take around 5 seconds to reach SOHO from earth. A significant level of design complexity has been included in SOHO, in order to allow it to manage and control its own functions for up to 48 hours in the event of interruption of daily communication.

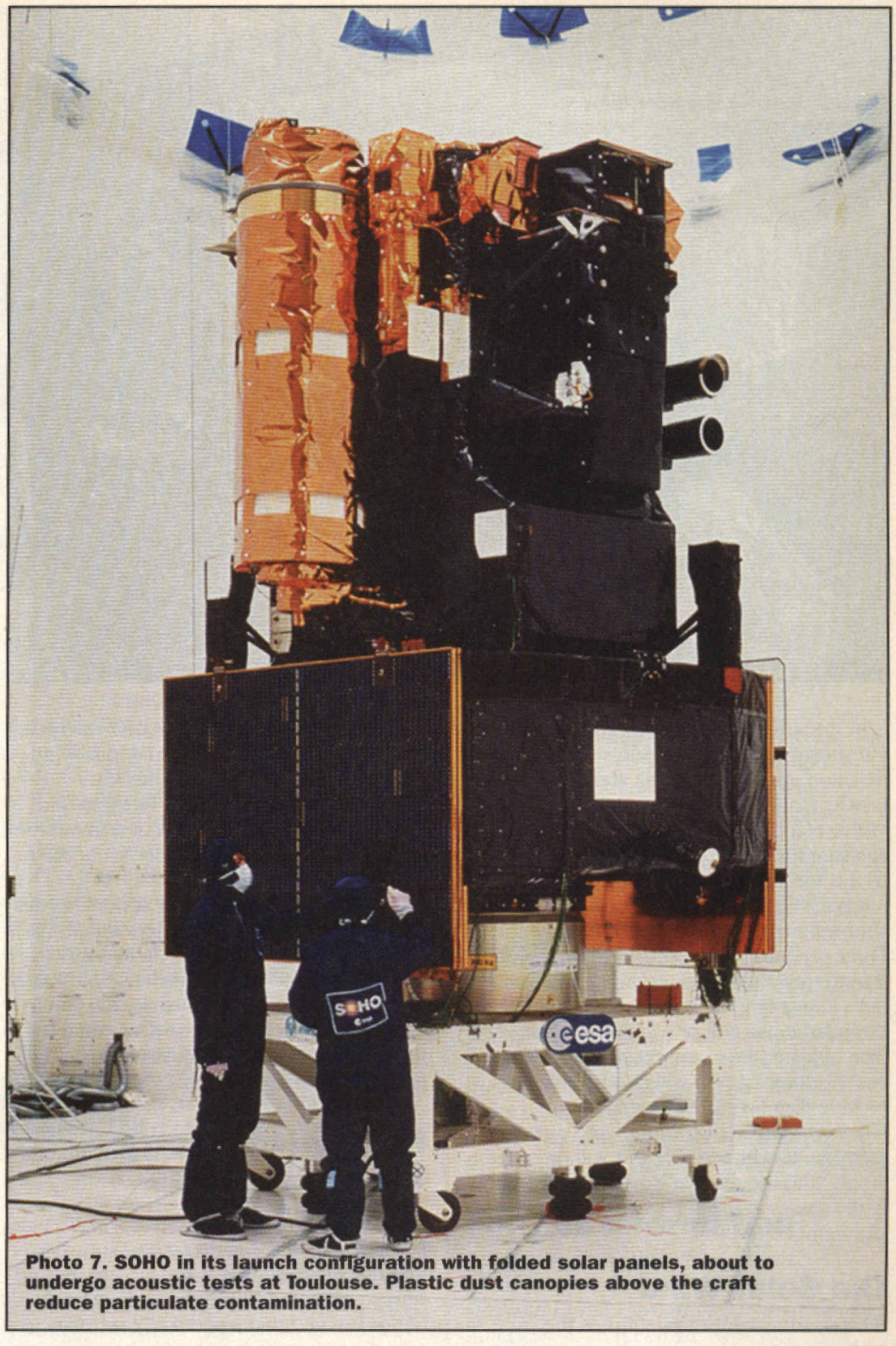


Photo 7. SOHO in its launch configuration with folded solar panels, about to undergo acoustic tests at Toulouse. Plastic dust canopies above the craft reduce particulate contamination.

COURTESY: ESA.

Mapping in the Ultra-violet Region

One of the deeper mysteries of the sun is its atmosphere, or corona. While the upper surface of the photosphere has a temperature of around 10,000°C, the gasses in the corona can have temperatures in excess of one million degrees. The precise mechanism of transference of energy is unclear. At these very high temperatures, the peak of black body radiation shifts to shorter and shorter wavelengths – of the shorter ultraviolet and even the X-ray. The largest group of experiments on SOHO will seek to record the complex emission patterns in the ultra-violet regions. The SUMER (Solar Ultraviolet Measurement of Emitted Radiation) experiment on SOHO is able to resolve features smaller than 1,000km, and will scan an 80,000km strip of the sun forty times an hour.

The CDS (Coronal Diagnostic Spectrometer) device, developed in the UK, will scan at shorter wavelengths. The variation in signal intensity will also provide details of density of the corona. UV emissions associated with specific spectral transitions will have their wavelengths altered due to their relative motion (Doppler Effect). This will, in turn, provide information about the relative speeds of areas within the corona. The EIT (Extreme Ultraviolet Imaging Telescope) will provide full disk images, but at lower resolution. The SUMER, CDS and EIT experiments will allow also velocities to be determined down to values of 1km/s.

A separate American-Italian instrument, UVCS (Ultraviolet Coronagraph Spectrometer), will observe the corona out to a distance of 7×10^6km – equivalent to five times the sun's diameter. This system will observe emission spectra of a range of elements including hydrogen, and also provide information about the speed of jets in the corona.

PHOTOS COURTESY ESA.

Photo 8. Face of SOHO with solar-directed instruments. In addition to sealed door/aperture systems, individual plastic covers further reduce particulate contamination.

In the sun's high temperature corona, free electrons scatter the sun's visible radiation. An occulting disk aboard the LASCO (Large Angle Coronagraph for Visible Light) experiment will seek to measure the dim visible sunlight produced by this mechanism. Such observations are not possible from beneath the Earth's atmosphere, due to the scattering of light. Three separate viewing coronagraphs will be able to view the corona from 1·1 to 30 solar radia in overlapping ranges. Such an extended range will provide more data than obtained from any previous space observations. LASCO will also be able to provide data on electron densities in relation to global distribution and radial variation. It is hoped that this will provide insight into the mechanisms of heating of the gasses in the sun's corona to such high temperatures.

The Solar Wind

Whatever mechanism establishes the high temperatures of the solar corona, the energy of a large number of components of the corona is sufficiently high to break free from the sun's gravitational attraction. This is the origin of the solar wind – a rarefied mixture of protons, electrons and magnetic fields which fills the apparent emptiness of the solar system. As particles leave the upper reaches of the corona for their outward escape route, new material rises up from the photosphere to replace them.

Studies by spacecraft at Earth's orbit have identified two specific streams of the solar wind. One propagates at a relatively slow speed of between 300 and 400km/s while a higher set travels at between 600 and 800km/s.

It is thought that the high speed component breaks out of so-called coronal holes of low ultra-violet and X-ray activity. The radial direction of the sun's magnetic field at these points is thought to provide a fast escape route for charged coronal particles. The slower component of the solar wind, however, is poorly understood.

An array of detectors on SOHO will seek to sample particles of the sun's solar wind. A joint German, Swiss and American experiment CELIAS (Charge Element and Isotope Analysis System) will determine the chemical identity of the particles and their relative charge.

COSTEP (COmprehensive Supra Thermal and Energetic Particle Analyser) will monitor energy spectra of electrons up to 5MeV and protons and helium nuclei up to 53MeV per nucleus. Energies of heavier ions up to 540MeV per nucleus will be detected by ERNE (Energetic and Relativistic Nuclei and Electron Experiment).

Helioseismometry: Taking the Pulse of the Sun

Perhaps one of the earlier major surprises that the sun yielded was the fact that sound waves propagate within the various layers of the sun and that a pattern of resonances causes sections of the photosphere to rise up and down in various forms of complex harmonic motion. Oscillations originating from deeper layers tend to lead to periods of several hours, while more surface linked phenomena are present, with shorter periods. In an analogy with seismology on Earth, the study of surface oscillations of longer and longer periods it is hoped, will establish some of the physical properties inside the sun's deep interior.

Figure 1 indicates the nature of vibrational resonances thought to be established within the sun's interior.

The GOLF experiment (Global Oscillations at Low Frequency) and VIRGO (Variability of Solar IRradiance and Gravity Oscillations) are designed to detect long period oscillations and sound waves that can penetrate the deep solar interior. The Solar Oscillations Investigation/Michelson Doppler Imager or SOI/MDI is designed to obtain data on smaller spatial scales but with exceptional accuracy.

Also, it is thought that various non-uniform mass concentrations within the sun's deep structure give rise to gravity waves that slowly distort its upper structures. These slow components of change will be closely monitored by VIRGO.

The GOLF and SOI/MDI experiments utilise the Doppler principle for measuring the motions of the photosphere. The light from an active region of the photosphere contains contributions from characteristic line spectra of a range of elements. As these radiating sources move upwards, the wavelength of the corresponding emission spectra is reduced and conversely is increased when moving downwards.

The GOLF experiment is designed to measure velocities as low as 1mm/s for global surface oscillations with periods from 3 minutes to 100 days. This corresponds to a change of 200Hz in a frequency associated with green light at 0·5μm. The SOI/MDI experiment will obtain similar data but with higher spatial resolution and seek to identify phenomena over short time scales. The extensive data obtained from both experiments will help scientists model the radial distribution of density, pressure and temperature of the sun. Also, such data should enable detection of any variation of rotational speed with depth and latitude and hence provide insight about possible mechanisms for the generation of the sun's extensive magnetic field.

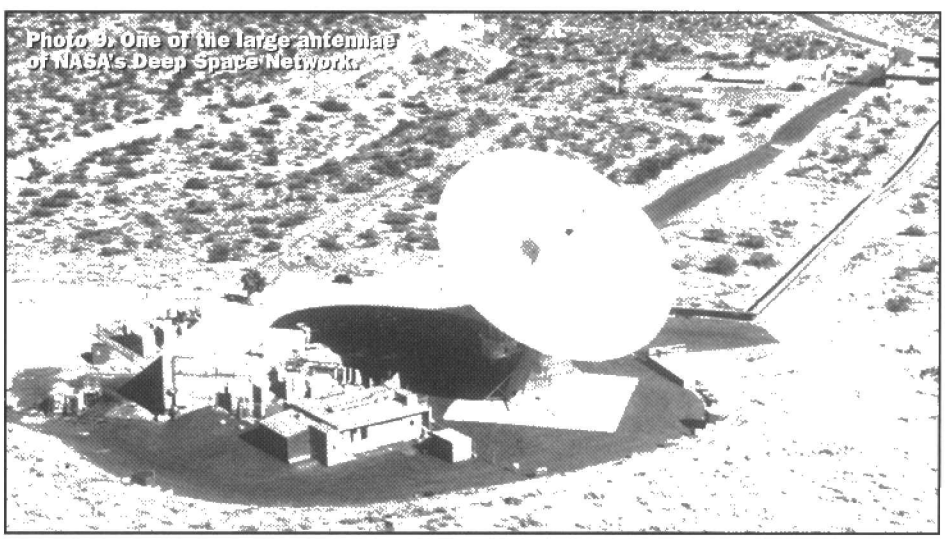


Photo 9. One of the large antennae of NASA's Deep Space Network.

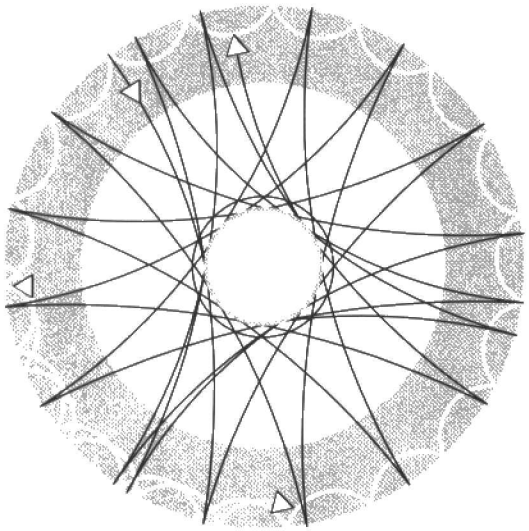


Figure 1. Nature of vibrational resonances thought to exist within the sun's structure.

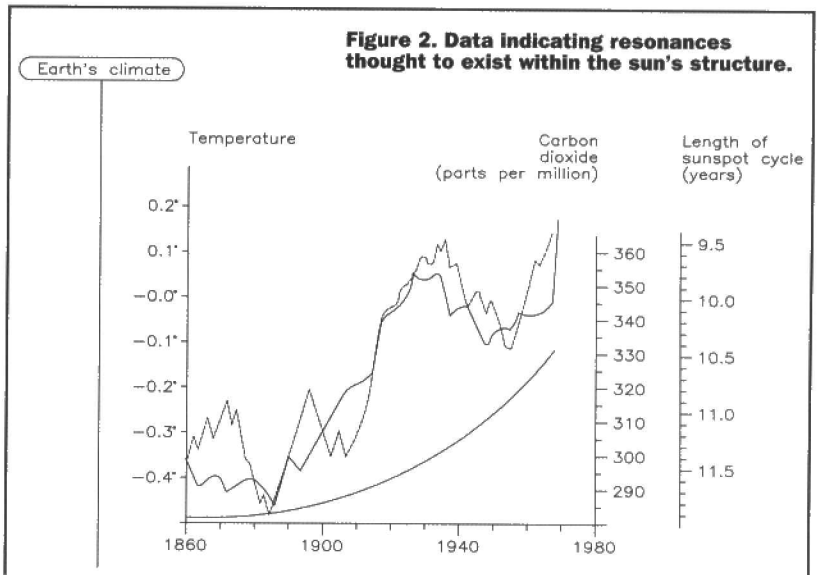


Figure 2. Data indicating resonances thought to exist within the sun's structure.

One of the long-standing problems with current scientific theories is the apparent lack of numbers of neutrinos generated at the sun's core by fusion processes. The information obtained by SOHO's helioseismology may be able to assess more accurately the conditions of the sun's interior and help reconcile a revised model of the sun with the solar neutrino activity that is registered on Earth.

The Sun's Role in Climate Change

With the Earth's climate systems finely balanced on a knife edge, even slight changes in the sun's total luminous output can have a significant effect on the Earth's climate systems. The VIRGO experiment onboard SOHO will seek to make measurements of the sun's output using extremely accurate, precise and stable radiometers. Such data will be especially valuable to understand more fully variations in Earth's climate caused by fluctuations in the sun's output.

As increasingly, climatologists link rises in global temperature with increasing levels of carbon dioxide, opposing theories of solar-terrestrial physicists in Copenhagen link instead the apparent rise in Earth's temperature with a reduction in the period of the sun's sunspot cycle. According to this theory, Earth cooling is associated with an increase in the solar sunspot cycle and conversely, a decrease in sunspot cycle is associated with global warming.

The data indicated in Figure 2 of global temperature change to inverse scale of sunspot cycle period certainly looks interesting. The work of SOHO, in measuring the output of the sun over extensive ranges of spectra and at various phases within the sunspot cycle will, hopefully, finally clarify the issue of why is it getting hotter on earth.

Looking again at Figure 2, one can imagine some periodic fluctuation in temperature based on solar cycles, with probably a general upwards lift from the effect of increasing levels of carbon dioxide. There is no doubt, however, that the data obtained by SOHO will be of immense value to scientists who are developing computer models of the Earth's Climate.

First Data

Initial reports of SOHO's experiments at its observing position are exceedingly good. According to Dr. A. Poland, mission specialist at Goddard Space Center, all twelve experiments are functioning very satisfactorily. Within a craft of such complexity, this level of performance is almost unheard of.

There is considerable interest in the GOLF experiment, which is demonstrating a signal-to-noise ratio a factor of ten better than Earth-based observations using radio telescopes. Initial observations have also indicated that some of the 'data' previously obtained was, in fact, due to perturbations in the Earth's atmosphere.

The UV imaging experiments are providing images of coronal distributions and in addition, data on temperature, velocity and height within the corona. While the mystery of the super hot gases in the corona is not yet solved, the data being obtained by SOHO will help develop models of solar function to explain this phenomenon.

Experiments in observing the Solar Wind are identifying elements never before detected by satellites. This is largely due to the greater sensitivity of SOHO's particle detectors and its constant pointing observing mode.

As observing continues, it may be some time before extensive series of experiments are written up in the scientific literature. Data on SOHO can, however, be inspected on SOHO's home page on the Internet. See points of contact for details.

CLUSTER – Adieu

The failure of the CLUSTER launch on the 4TH of June on a test launch of Ariane 5 is a great disappointment to the many scientific teams around the world and in particular, to those at Rutherford Appleton Laboratory in the UK, who had worked so hard for so long in developing the advanced technology of the CLUSTER craft and would have played a key role in processing its data. The fact that SOHO and CLUSTER were to be twin missions, with SOHO an outpost and CLUSTER a series of observing satellites in Earth orbit, indicates the significance of the loss of the near-Earth observing facility of CLUSTER.

Hopefully, however, the gap in near-Earth observing of the solar wind activity can be filled before the observing life of SOHO comes to an end.

The outstanding success of SOHO's set of experiments, however, is an indication of the success of transnational co-operation and technical achievement. Also, it would have been more fitting if reports of CLUSTER's demise had been tempered by reports of SOHO's success.

Summary

In understanding our own sun better, this knowledge will be of key value in the theories of cosmology and astronomy that relate to stellar evolution and function throughout the universe. It should also make us more aware of our fragile existence on a blue/green planet speeding through the emptiness of space. ELECTRONICS

Further Information

Blinded by the Light, John Gribben, Black Swan Publications, 1991.
Sun and Earth, Herbert Friedman, Scientific American/W. H. Freeman, New York, 1986.

Points of Contact

European Space Agency,
Public Releations Division,
8-10 rue Mario-Nikis, 75738,
Cedex 15, Paris, France
Tel: (0033) 153 69 71 55.
Fax: (0033) 153 69 76 90.

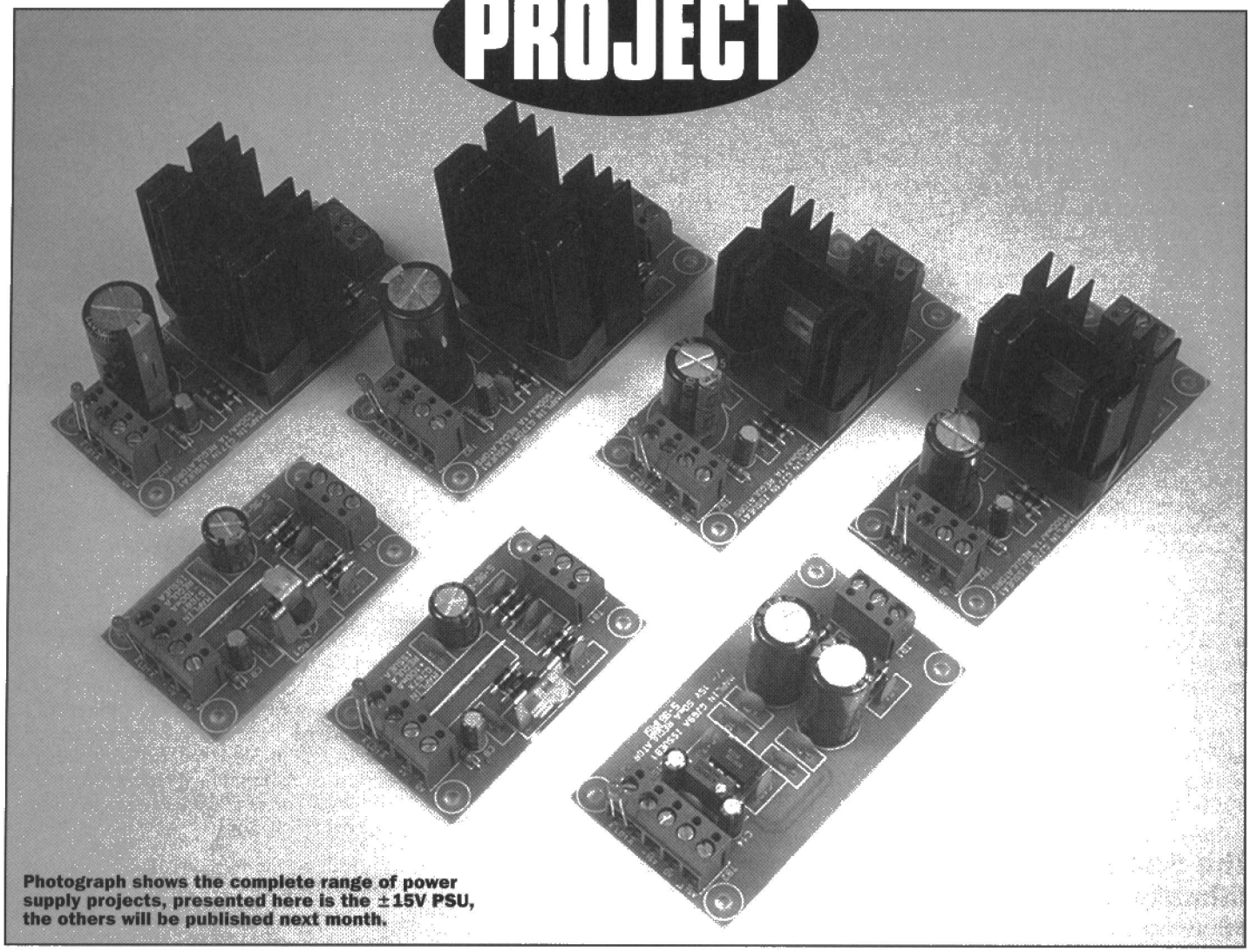
ESA, ESTEC, Noordwijk, The Netherlands.
Tel: (0031) 1719 83 006.
Fax: (0031) 1719 17 400.

Internet Sources

ESA press releases and other information can be found on the World Wide Web.
ESA home page: **http://www.estec.esa.nl**
ESA press releases: **http://www.ersin.esa.it/htdocs.tidc/Press/press95b.html**

The SOHO homepage is maintained by the Goodard Space Center and can be found at: **http://soho.www.nascom.nasa.guv**
This will contain a range of observing clips of SOHO's data.

PROJECT



Photograph shows the complete range of power supply projects, presented here is the ±15V PSU, the others will be published next month.

FEATURES

- Dual polarity tracking
- Short-circuit protected
- Over-temperature shutdown
- Power on indication
- Compact board dimensions

APPLICATIONS

- Dual-rail regulated DC PSUs
- Ideally suited to op-amp circuits

PROJECT RATING 3

Kit Available
Order as 95162
Price £7.99

±15V REGULATOR KIT

Design by Alan Williamson
Text by Alan Williamson and Maurice Hunt

This ±15V Regulator kit is based on the RC4195N, an 8-pin dual polarity tracking regulator integrated circuit, designed to provide balanced positive and negative ±15V DC outputs, at currents of up to 100mA (peak) per rail. The IC is fully protected against short-circuits, and shuts down if its internal temperature exceeds 175°C, making it the ideal choice for use in a general purpose regulated DC power supply, or for use with operational amplifier circuits.

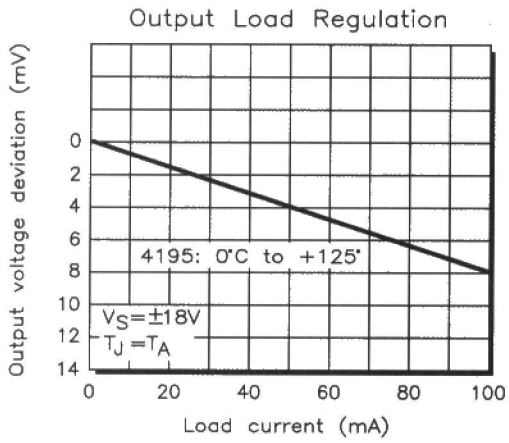


Figure 1. Output load regulation graph.

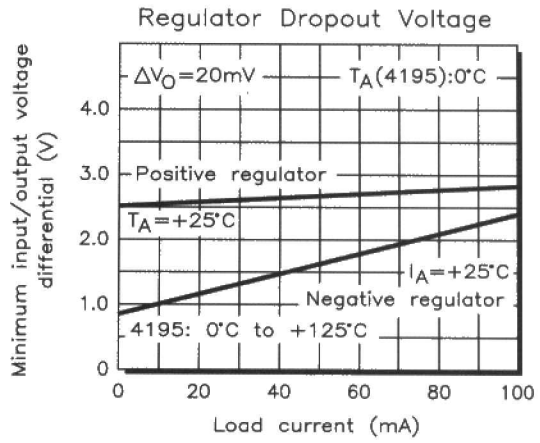


Figure 2. Regulator dropout voltage graph.

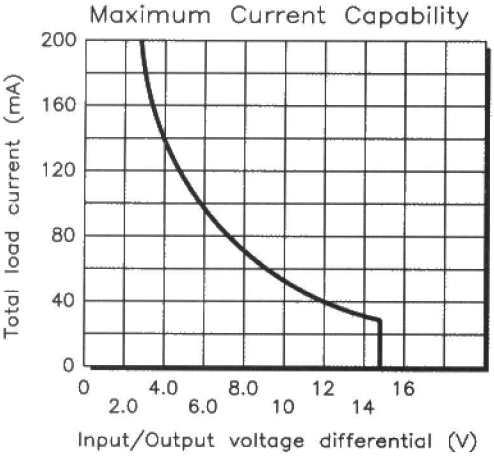


Figure 3. Maximum current capabilities graph.

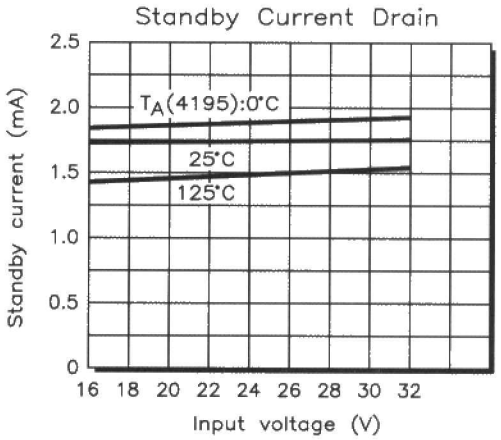


Figure 4. Input voltage graph.

The various performance aspects of the RC4195N regulator IC are detailed in the graph plots, see Figures 1 to 6. The ±15V Regulator Kit is built onto a compact, single-sided board, connections being made via onboard terminal blocks. Provision is made for accurate balancing of the output rails with a negative rail trimmer, and for optional power on indication.

Circuit Description

Refer to Figure 7, showing the circuit diagram. The stepped-down AC voltage from the transformer secondary windings are fed into the bridge rectifier formed from diodes D1 to 4. Capacitors C1 to 4 prevent noise/interference from the diodes. Capacitors C5 & C6 act as low-frequency decoupling, while C7 & C8 provide high frequency decoupling. The extremely large values of C5 & C6 (considering the current drawn) are required because IC1 has only 75dB ripple rejection, and the larger C5 & C6 are made, the lower the input ripple – the output ripple of the regulator will then be 75dB down from the (now) small input ripple.

IC1, the pinout, functional block diagram and internal circuit of which are shown in Figures 8, 9 and 11, achieves the regulation of the DC supply being fed into it. Capacitors C9 & C10 connect the compensation inputs of the IC to the negative side of the bridge rectifier and the 0V rail, respectively.

Potentiometer RV1 is used to balance the two output supply rails, so that they can be closely matched, but of opposite polarity.

Capacitor C11 provides common mode noise rejection of the output, while C12 and C13 provide differential mode rejection.

C14 & C15 achieve low-frequency decoupling of the output. Resistor R1 limits the current applied to the power on LED, LD1 (if fitted).

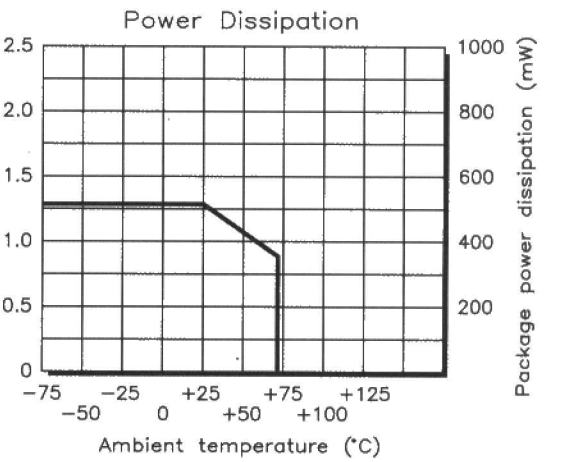


Figure 5. Ambient temperature graph.

SPECIFICATION

Operating voltage:	20-0-20V 50Hz AC
Output voltage:	±15V DC dual-rail, or 30V DC single-rail, regulated
Maximum output current:	50mA continuous (per rail), 100mA peak
Short Circuit current:	220mA @ 25°C
Maximum power dissipation:	600mW
Output voltage drift with temperature:	0·005%/°C (typ), 0·015%/°C (max)
Output voltage tracking:	±50mV (typ), ±300mV (max)
PCB dimensions:	78 × 42mm

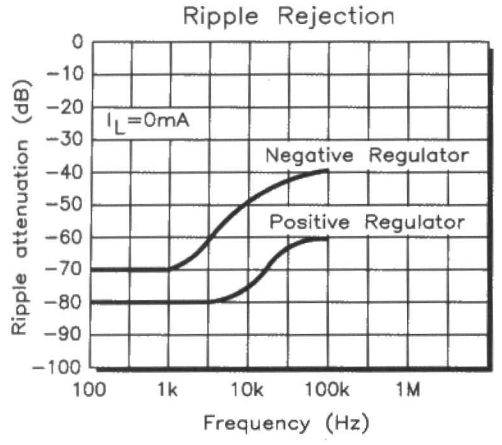
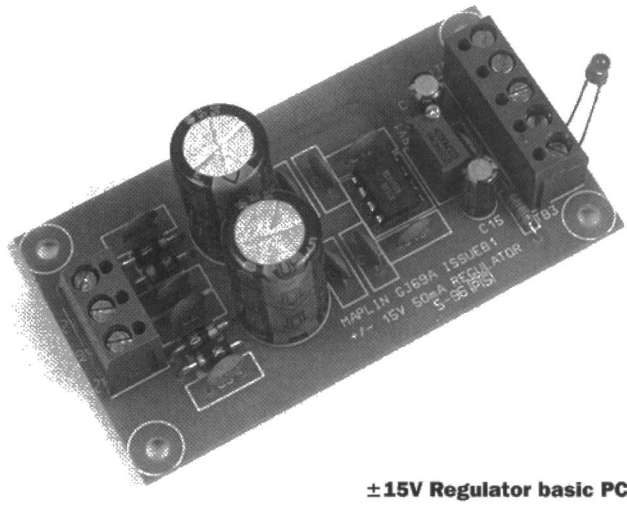


Figure 6. Frequency graph.



±15V Regulator basic PCB.

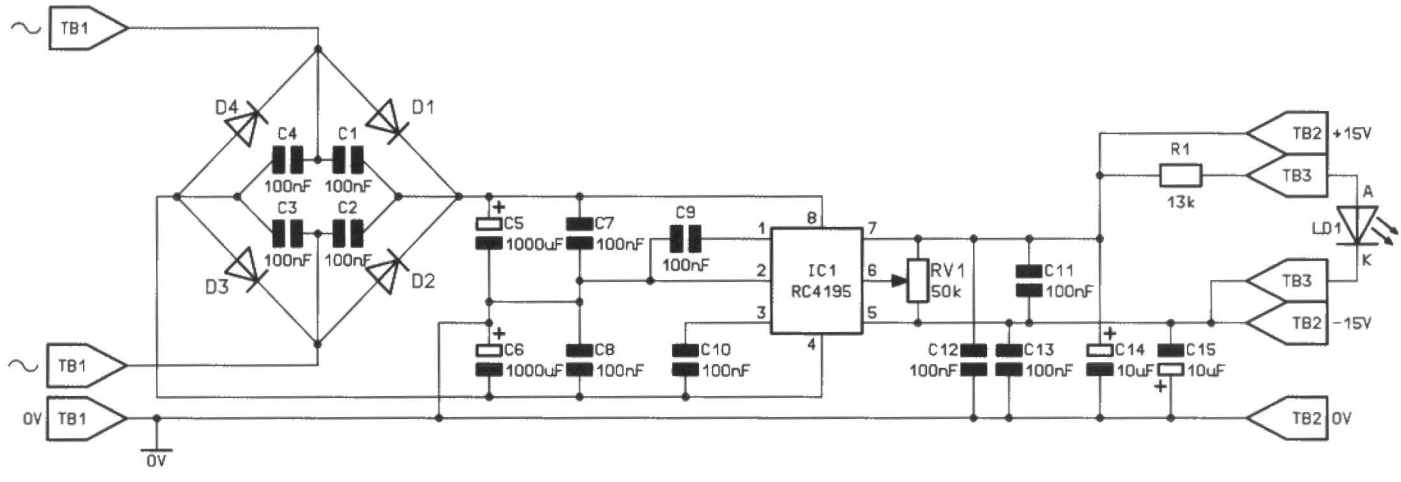


Figure 7. Circuit diagram.

PCB Assembly

Refer to Figure 12, showing the PCB legend and track, and to the Constructors' Guide if you are a newcomer to project building. Assemble the board in order of ascending component size/height, taking care to install the polarised components (electrolytic capacitors and diodes) with the correct orientation, as indicated by the legend. Install IC1 so that its end notch aligns with that of the legend, and fit the terminal blocks so that their access holes face outwards. Note that an IC holder should NOT be fitted, as the PCB tracks are used as a heatsink for IC1.

Having assembled the board, CAREFULLY check your work for misplaced components, solder bridges, whiskers or dry joints, then clean excess flux off the board using a suitable solvent.

Testing and Use

Connect the optional transformer to the board at terminal block TB1, and the LED, LD1, to TB3, as shown in Figure 13 (note orientation). The mains wiring to the transformer primary winding is shown in Figure 14. Once everything is connected to the board, check the continuity for short circuits, etc. With the unit installed in a suitable box and with the lid closed, turn the power on. If fitted, the LED LD1 should illuminate, indicating that power is presenting at the output terminals. Now, using a multimeter, measure the voltage between the 0V and +15V & −15V terminals of TB2. The reading should be +15V and −15V DC ±0·5V, respectively.

If fitted, adjust the optional potentiometer RV1 as necessary (see Figure 10), to obtain equally matched, but of opposite potential readings (i.e., balanced) at the two output terminals. The ±15V Regulator is now ready for use. Note, if RV1 is omitted, the output rail voltages may differ by up to 300mV.

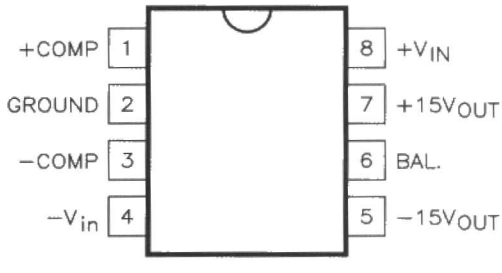


Figure 8. RC4195 pinout.

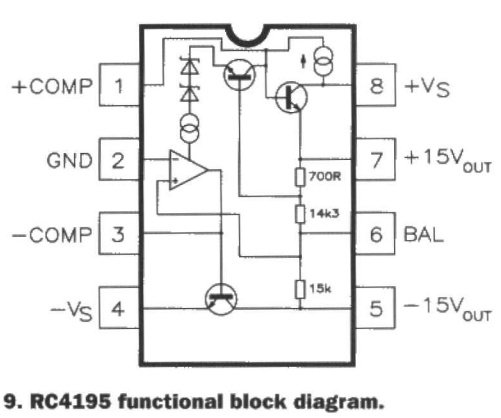


Figure 9. RC4195 functional block diagram.

Important Safety Note

It is important to note that mains voltage is potentially lethal. Full details of mains wiring connections are shown in this article, and every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit, which should never be operated with the box lid removed. Safe construction of the unit is entirely dependent on the skill of the constructor, and adherence to the instructions given in this article. If you are in any doubt as to the correct way to proceed, consult a suitably qualified electrician or engineer.

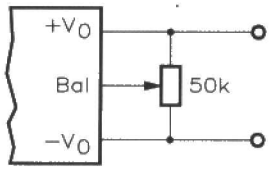


Figure 10. Balancing the output rails.

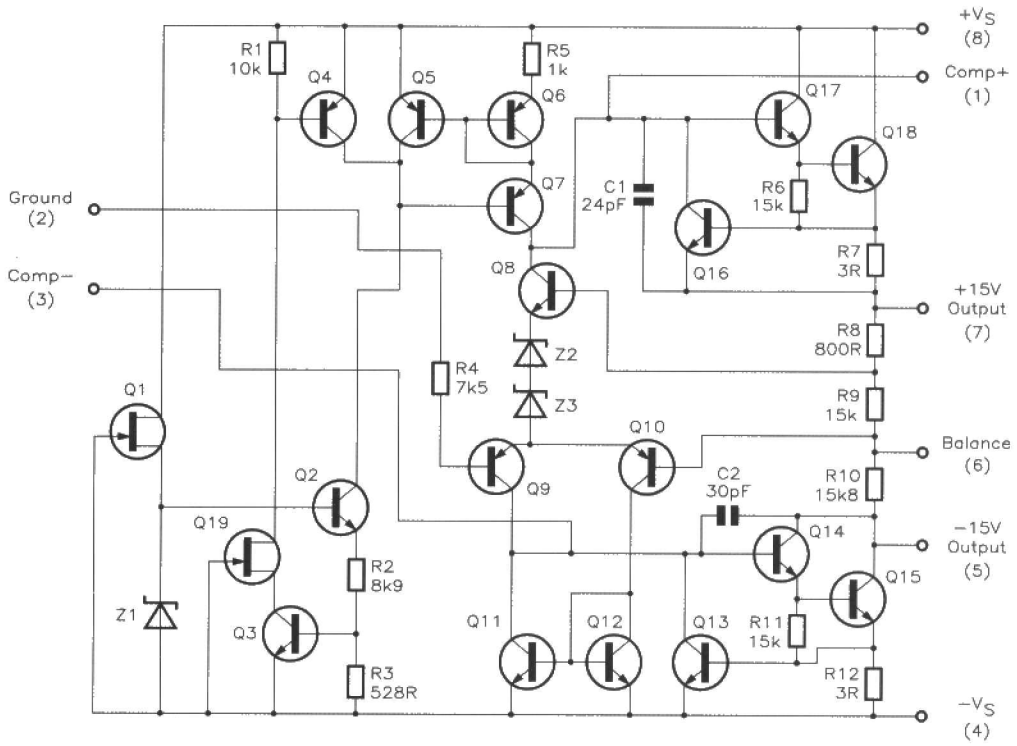


Figure 11. RC1495 circuit diagram.

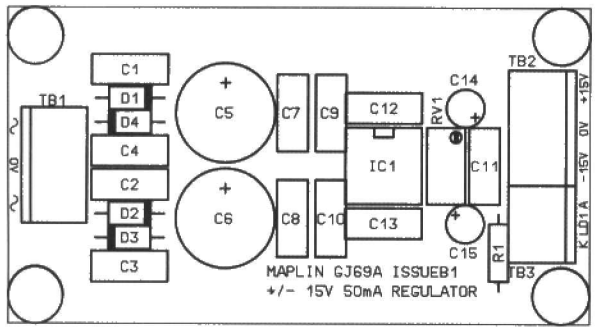


Figure 12. PCB legend and track.

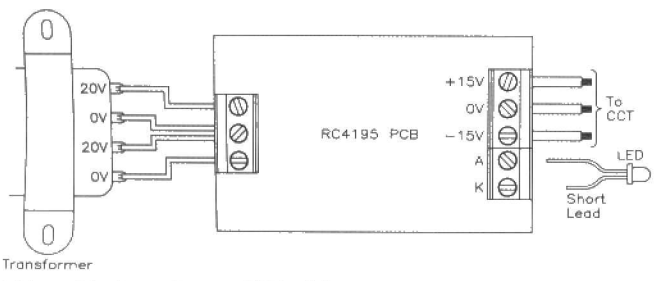


Figure 13. Transformer/PCB wiring.

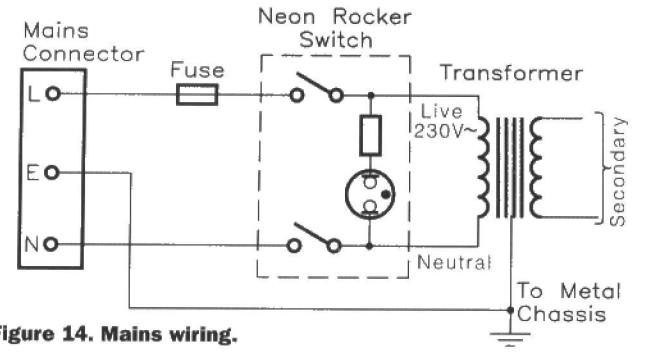


Figure 14. Mains wiring.

PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless stated)			
R1	13k	1	(M13K)
CAPACITORS			
C1-4,7-13	100nF 50V Ceramic Disc	11	(BX03D)
C5,6	1,000µF 35V Radial Electrolytic	2	(AT63T)
C14,15	10µF 63V Radial Electrolytic	2	(YR75S)
SEMICONDUCTORS			
D1-4	1N4001	4	(QL73Q)
LD1	3mm Red LED	1	(CZ28F)
IC1	RC4195	1	(XX02C)
MISCELLANEOUS			
TB1,2	3-way 5mm PCB-mounting Terminal Block Type 300	2	(JY94C)
TB3	2-way 5mm PCB-mounting Terminal block Type 300	1	(JY92A)
	PCB	1	(GJ69A)
	Instruction Leaflet	1	(XZ33L)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
RV1	50k 22-turn Cermet Potentiometer	1	(UH26D)
T1	6VA 230V to 20-0-20V Transformer	1	(WB16S)
FS1	50mA Time Delay Glass Fuse	1	(CZ85G)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding optional) are available as a kit, which offers a saving over buying the parts separately.

Order As 95162 (±15V Regulator Kit) Price £7.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1996 Maplin Catalogue.

±15V Regulator Kit PCB **Order As 95182 Price £2.49**

Car Navigation GLOBAL POSITIONING SYSTEM SOFTWARE

by Robin Lovelock

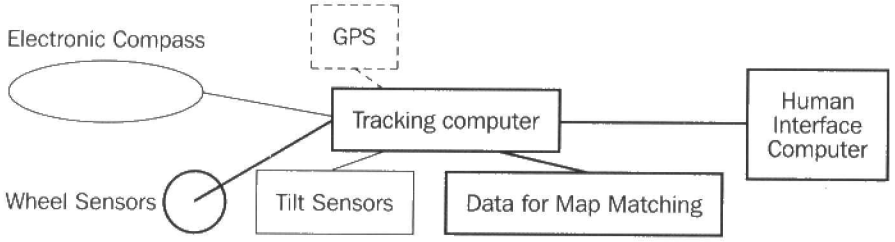
Calculator-sized GPS satellite receivers and Notebook PC computers loaded with software (distributed free) provide the UK motorist with facilities more advanced than the most sophisticated car navigation system from Japan, see Figure 1.

The computer displays the cars position on a map and speaks, to actually tell you where you are, e.g. "We are 25 miles West of London and 2·5 miles North East of Reading". It can search for places such as the nearest petrol filling station: "..the nearest filling station is Esso filling station, 3 miles ahead at your 12 o'clock" – or eating places: "..the nearest eating place is Little Chef on the A329, 6 miles to our right at your 2 o'clock". It can guide you to places, by reminding you where it is relative to the car: "Destination Little Chef, 700 yards ahead at your 11 o'clock". Directions are given in the style of those to a fighter pilot. i.e. "12 o'clock" is directly ahead, "3 o'clock" is to the right, etc..

The software is British, and in advance of systems pioneered by the Japanese or still being developed in Germany for release in the UK next year. This advanced software, called 'GPSS' (Global Positioning System Software), featured in numerous different television broadcasts in the past year, including both ITV and BBC Television news coverage of the London Motorshow. A free version of GPSS is distributed regularly on different PC magazine CD-ROMs. Upgrades to GPSS are available from Sunninghill Systems, which include more detailed mapping (e.g. the 1,000 towns in the free version are increased to 27,000 villages), speaking Japanese in addition to English, or software configured to track multiple vehicles over communications such as radio or Inmarsat-C. The same software is now being used by various organisations, including the UK Defence Industry, Police and business. It is also being used throughout the country by a rapidly growing community of 'GPS on the road' enthusiasts.

FIRST GENERATION OF CAR NAVIGATION SYSTEM

- *Pioneered in Japan, then USA and Europe*
- *Does not require GPS*
- *Uses 'Map Matching' of wheel movement*
- *Wired into vehicle sensors*



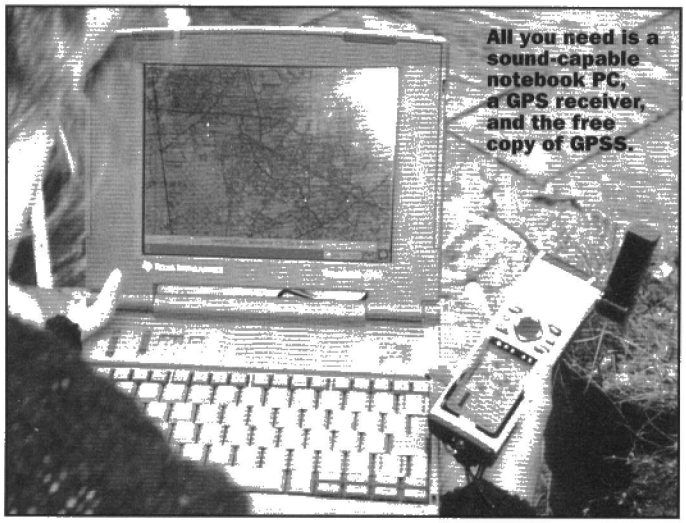
NEXT GENERATION OF CAR NAVIGATION SYSTEM

- *Exploits GPS – now adaquate, getting better (10m)*
- *Exploits PC Computers – smaller, cheaper, more power*
- *Exploits PC software – voice recognition, telecomms*
- *Independent of the vehicle in which it is used.*

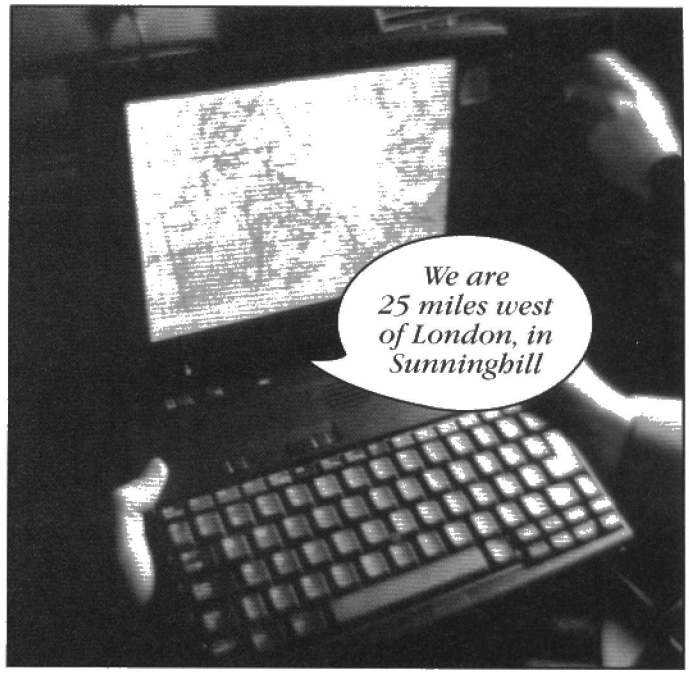
Figure 1. Generations of Car Navigation Systems.

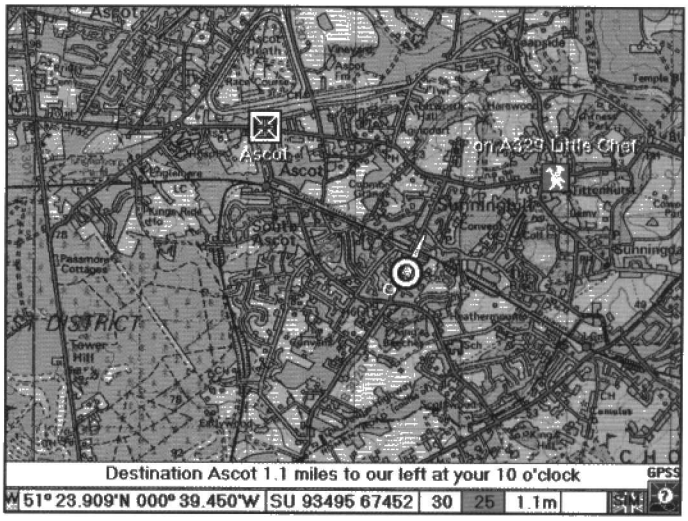
What is GPS?

GPS – the Global Positioning System – is a network of satellites launched for use by the US Military. It is now being exploited world-wide, and the calculator-sized GPS receivers are getting smaller and cheaper. These receivers pinpoint your position accurately, anywhere in the world. They are already available for less than £200, and are appearing on the high street in Maplin shops, Mondo stores and other shops soon. There are no hidden costs, beyond the cost of the receiver, and the US Government have promised to give 10 years notice of any change in policy in provision of the service, to an accuracy of typically 100m. More expensive 'differential' receivers can provide much greater accuracy of better than 10m, although this may soon be unnecessary, as the Americans are expected to stop feeding in the 'deliberate error' which has limited accuracy to 100m. Many of these GPS receivers have what is known as an NMEA interface – RS232 data as ASCII text, that can be plugged into the COM port of a notebook computer and used in a moving car. The GPS data provides position as latitude and longitude, and velocity as a course and speed. Some GPS receivers are now designed for use with a PC computer. They do not need buttons or a display. They simply consist of a matchbox sized plastic box with two leads: one that plugs into the car's cigar lighter socket for power, and the other that plugs into the computer.



All you need is a sound-capable notebook PC, a GPS receiver, and the free copy of GPSS.





The GPS Software displays the car's position on a map and speaks.

What is this Free GPS Software?

The 'freebie' version of GPSS will work anywhere on the UK mainland. It includes:

- Navigation maps covering the whole UK mainland, accurate to about 1 mile.
- Sample aerial photographs and detailed maps from Bartholomew's and Ordnance Survey.
- Over 1,000 towns, 2,200 petrol filling stations, 850 eating places, 300 hotels, and 700 interesting places to visit, such as National Trust and English Heritage sites.

The two floppy disks include installation instructions on the labels. Follow the instructions to run a DOS batch file which creates a directory (e.g. C:\GPSS03) and decompresses the files into it. You then click on FILE-NEW, etc., to link a displayed icon to the GPSS program (C:\GPSS03\GPSS.EXE).

If run on a desktop PC, it will provide a simulated journey. If a GPS receiver is connected, it will work 'for real' after saying with enthusiasm, "I am receiving GPS data!" A user book, without illustrations, is provided as file BOOK.TXT. The online help – switched on by hitting the '?' key – gives operating instructions and a list of GPS suppliers.

The GPSS software has been designed for use with voice recognition packages. This permits conversations such as in Table 1 between the driver and his computer – while he keeps his 'eyes on the road'.

Driver	Computer
"Where are we?"	"We are 25 miles west of London, in Ascot ... moving north on the B3020 ... our destination is 500 yards ahead at your 1 o'clock."
"Eating place?"	"OK ... the nearest eating place is Little Chef on the A329, 2 miles on our right at your 2 o'clock."
"Search"	"OK ... the nearest eating place is Public House 2·3 miles ahead at your 12 o'clock."
"Destination"	"Destination is Public House, 27 miles West of London and in Ascot."
"Sleeping place?"	"OK ... the nearest sleeping place is The Berystede hotel and restaurant, 600 yards behind us at your 6 o'clock ... more information is available."
"Tell me more"	"The Berystede Hotel is Forte Heritage. The telephone number is ..." etc. (A photograph of hotel appears.)

Table 1. Voice recognition commands.

Who Wrote the Software?

GPSS is the brainchild of the author of this article, Robin Lovelock, who describes himself as a 'not so mad scientist'. Until recently, his career had been in advanced military computer systems. He 'cut his teeth' on computers in the '60s, worked for ten years as a senior scientist at an overseas NATO Research Establishment, then returned to the UK and worked for 13 years with a British Defence Contractor. He started his own software business at the end of 1994. 'Sunninghill Systems' is a small family business, based in Sunninghill, near Ascot in Berkshire. Robin and his wife June run the business, but their three daughters – all computer literate – take an active part. All of the business is confined to the supply of software for GPS-based systems.

Why is the Software given away for Free?

The software given away free includes detailed mapping of the UK and voice guidance. Robin believes that this software represents just the 'tip of the iceberg' of what is possible – and for which he has ready solutions! He firmly believes that PC computers will become commonplace within cars very soon – either built into the car – or as a notebook (or pocket) PC carried by the driver or passenger. The basic GPSS package is being distributed free to encourage the GPS market to develop more rapidly in the UK. Businesses offering intelligent GPS antennas, or integrated GPS & PC solutions, can use the free version of GPSS to get their products 'off the ground'. A small proportion of 'free GPSS' users will wish to buy the fuller product or tailored GPSS solutions.

Why is the GPSS Software on 11 Floppy Disks Instead of CD-ROM?

The majority of suitable sound-capable laptop or notebook computers (that people currently have, or can afford) do not have CD-ROM drives. The software can be loaded directly onto any of these computers. Later versions will be available on both CD-ROM and floppy disk.

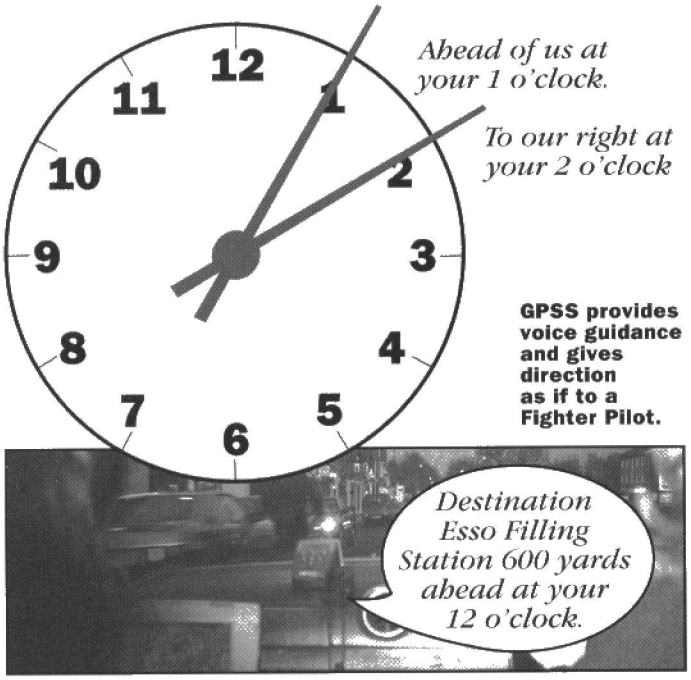
Sunninghill Systems provide a free installation service – including a road test with GPS – for users who do not want to spend up to an hour loading the software (although the SETUP program is more interesting than most, since it plays the sounds and displays the maps as they are being loaded!)

Why can GPSS speak English and Japanese?

GPS is an American system, GPSS is British software (for use on the UK mainland) but the Japanese are the first nation to buy GPS consumer products on a grand scale. Over a million Japanese cars are fitted with GPS (but not as sophisticated as the GPSS product). The Japanese know what GPS can do, and some living in the UK may buy the software to see more of the UK countryside – without the danger of getting lost on our smaller roads.

What's So Special about a 'Talking Computer'?

We communicate by speech. It is now technically and economically feasible to communicate by speech with computers. This is particularly important in cars, where the driver should 'keep his eyes on the road'. We also associate 'personality' with the voice. Perhaps different computers will be given a voice according to the type of car and owner. What would you prefer: a posh butler, a sexy female voice, clipped male military, or west country yokel? Or perhaps you want it to sound like a computer, and speak like an American dalek! Early versions of GPSS used text-to-speech software (as in the Soundblaster games like Dr Sbaitso) and sounded just like an American Dalek. The released versions of GPSS use recorded speech for more natural sounding (British) English and Japanese voices. Robin anticipates alternative voices being offered in the future, in response to what users want. Text-to-speech software will also get better soon – as will voice recognition.



GPSS provides voice guidance and gives direction as if to a Fighter Pilot.

Where Can I Buy Voice Recognition Software?

Voice recognition software suitable to run under Windows and emulate keyboard keystrokes is appearing from several sources. One of the least expensive is IN3 from Command Corp. in the USA at $50. This has been used with GPSS for several years. It is available on the Net, from `http://www.commandcorp.com/incub_welcome.html`. Their fax is (001) 404 813 0113, but they only sell on the Internet. Other voice recognition suppliers include Responsive Systems, Tel: (0171) 6024107,

GEC-Marconi Secure Systems, Tel: (01705) 664966, IBM and Microsoft. You can expect other voice recognition packages to become available during 1996.

What Other Uses of GPSS Are There?

GPSS is now being used in a host of applications other than that for which it is primarily intended, that is, use within a car, providing information to the driver and passengers.

It is also being used for military, police and business applications which require vehicles to be tracked and displayed on maps. GPSS can be configured to operate on a PC connected to a radio or telephone modem, and track a number of vehicles. Communications from the vehicles may be based on radio, Inmarsat-C, or the Securicor Datatrak system – which provides position without using GPS.

GPSS can also be used in radio direction finding applications, to triangulate the position of radio sources from bearings received from radio direction finding systems. You may have seen it on television or in the press, being used to track down escaped falcons!

GPSS has recently been modified to extend its use to 'in the air', on platforms that include hot air balloons. It can provide warning of the balloon's approach to 'no fly areas', such as sensitive livestock or unfriendly landowners!

Why have in-car navigation systems taken so long to arrive in the UK?

The majority of high performance car navigation systems now operating in Japan, or in development in Europe, may be described as being of 'the first generation', i.e. they do not rely on GPS, but use a sophisticated process of matching movement of the wheels with very accurate and complete map data. It was originally thought that this approach would result in cheaper and more reliable solutions for in car navigation. Provision of map data of the required quality for 'map matching' is a formidable task – and organisations like Ordnance Survey are working on it – but this takes time. Meanwhile, technology races on: GPS went officially operational in the summer of '95. The service is now reliable, even in the middle of London, and the Americans may soon switch off the 'error signal': All GPS receivers will switch overnight from 100m accuracy to 15m.

It also makes less sense to develop a special computer for a navigation system: mass-produced Psion3a or 486 Notebook processors have more power and are becoming cheaper. Good software, which takes years to develop, is also available for these PC computers. This 'next generation' of car navigation systems simply use GPS and some form of PC computer. They do not require data of the detail and completeness needed for 'map matching' – only that required to display (or speak) useful information to the driver, e.g. a simple displayed map and locations such as hotels or petrol filling stations. They can also exploit other PC computer products, such as speech recognition.

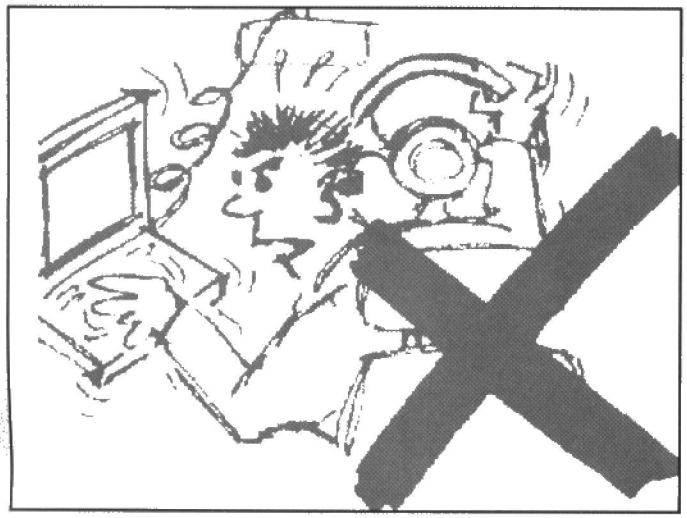
What Sort of Computer Do I Need?

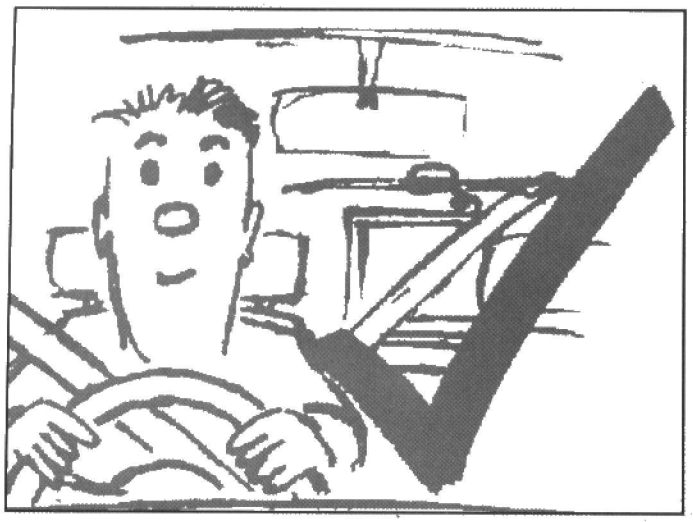
The most straightforward approach is to use any modern Notebook PC that includes a sound chip and runs Microsoft Windows 3.1, 3.11 or '95. Colour is nice, but even a monochrome VGA screen with grey levels show off the maps well. You may wish to add an amplified speaker if the sound from the internal speaker is not loud enough to be heard in the car – we cannot all afford to run a Daimler or a Rolls Royce! You will need less than 5M-byte of your hard disk for the GPSS 'freebie', including the maps and sound files. GPSS will run under Windows on a 286 with 3M-byte of RAM, but a 386 or 486 is recommended – particularly if you want to use it with voice recognition software.

An alternative 'budget' approach is to use a second-hand PC originally intended for the desktop, with a low cost sound card such as the 8-bit Soundblaster v2 – if you can still find one! This is probably the cheapest solution, since scanning the local small ads will often locate a suitable computer for less than £100 and the sound card for £20. However, you will pay as much again for the inverter to provide mains power from your car's 12V supply. The normal CRT monitor is a bit bulky for the car, so you may opt for 'sound only' or use a small portable television as a monitor. Using a TV will require the VGA video from the computer to be converted to PAL composite video, and – if your TV will not accept composite video – modulated to generate a UHF signal into the antenna socket. You will find suitable inverters, VGA/PAL converters and UHF modulators in the Maplin catalogue pages.

The third approach is to buy a PC-compatible computer designed to fit in the car or, if you have the resources, make one from modern components such as a board-level PC and TFT screen. The first product of this type to become available in the UK is the MCS-100 from Advanced Systems Solutions Ltd (A2S). More information is available from A2S, Tel: (01922) 57380.

As with all in-car equipment installations, follow the safety instructions (see below).





Make sure that you always follow the safety instructions!

Where Can I Buy a GPS Receiver?

There is one golden rule if you want to buy a GPS receiver for use with this software: insist on it having a standard NMEA interface. Most suppliers have NMEA products, but they also have products with non-standard proprietary interfaces, peculiar to the manufacturer and not supported by this software. The selling of GPS receivers is a fiercely competitive market, and you can expect prices to fall during 1996. Prices currently range between £200 and £900. All receivers should track accurately, but the lower cost receivers take a few minutes to 'lock on' to the satellites from switch on. They may also lose the signal in dense urban areas surrounded by high buildings. Despite this, even the cheapest receivers perform well, and products are improving each month.

The contacts below should be able to put you in touch with your nearest supplier of their products. The named products below have been tested with GPSS, and found to work correctly. Ensure you set the unit to WGS84, or you may find a consistent error of typically 100m to the south east. Don't worry too much about this, there are facilities in GPSS to apply a correction anyway!

Magellan

Magellan receivers such as the 'Trailblazer' are available from several sources. This is a good, moderately priced product, but the computer interface cable is sometimes supplied without a plug. Get a competent 'electronics man' to add the required 9-pin female D-type connector (Order Code RK61R). The signal wire goes to pin 2 and signal ground to pin 5.

Garmin

Typical products are the 'TrackPac PC', a low cost, matchbox sized 'intelligent antenna' and the GPS45 hand held unit with interface cable and external antenna as 'optional extras'. Contact James Turner, Tel: (01794) 519944 to find your nearest distributor.

Silva (UK)

Silva (UK) have two good suitable products: the 'Silva GPS Antenna', which provides an NMEA interface, and the 'GPS Compass' – which has a Silva proprietary interface, but can be supplied with another product which converts to NMEA. Contact Tony Wale, Tel: (01784) 471721.

Motorola

Motorola have an excellent performance 8-channel receiver for those who don't mind a 'box and mag-mount antenna' solution at a moderate cost. Distributors include Maplin – see issues 97 and 102 of *Electronics*.

Timble

Trimble have good quality products which tend to be a little more expensive. The 'Scoutmaster' hand-held unit and 'Locator' intelligent antenna can output in NMEA. Some Trimble products such as the PCMCIA 'gold card' do not support NMEA. Other 'box' products such as the SV6 are capable of being supplied configured for NMEA. Contact Trimble Navigation, Tel: (01256) 760150 to find your local supplier.

Peak Development

Peak Development distribute 'Scoutmaster' and 'Locator', contact Graham Beavis or Peter Weston, Tel: (01962) 713906. Diamond Point distribute the SV6 and are on (01634) 722390.

Scorpio Navigation

Scorpio Navigation Services provide differential GPS solutions. Contact: (0181) 951 4446.

Ashtec

Ashtec distribute professional GPS products: Contact is Karl Collins, Tel: (01993) 883533.

Rockwell

Rockwell supply chipsets to GPS receiver makers. Contact Adrian Ellis, Tel: (01344) 486444.

Further Information on GPSS?

For more information on GPSS and the range of applications to which GPSS can be applied, contact Robin or June Lovelock of Sunninghill Systems, Tel/Fax: (01344) 20775. If you have access to the Net, you will find lots of information, including the latest news such as the magazines with the 'freebie' on their CD-ROM, under GPSS on the home pages of Compuserve: `http://ourworld.compuserve.com/homepages/gpss`.

The Hi-Tech Experience

LONDON'S TROCADERO

by Alan Simpson

The new Trocadero complex, in the heart of London's West End, offers a challenge to all. The challenge is not to be impressed with the hi-tech, Hi-Fi, futuristic environment. When fully completed, it will be like 'nothing on earth' says Nick Leslau, chief executive of Trocadero plc. Certainly, the design suggests more an alien space station than an annex to the Piccadilly underground station.

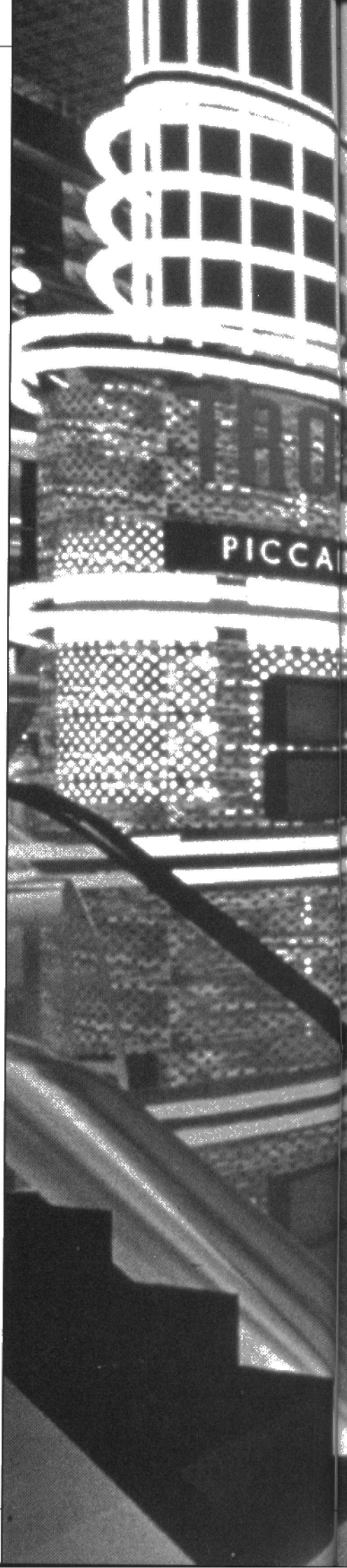
The out-of-this-world experience is contained in what is Europe's largest indoor entertainment complex. In this case, complex is probably the right term. The site contains not only Segaworld (the largest outside Japan) a huge video wall (yes, the largest in the world), special escalators (OK, the only ones of their type in the world), plus a range of restaurants, including the world-famous Planet Hollywood, but a 7-screen multiplex Lazer Bowl. Plus, of course, a world-first Internet facility.

A Landmark Site

Entangled in an intriguing web of London's history, the 1·8 acres of land where the Trocadero stands was owned before 1531 by both the college of Eton and Mercer's company, one of London's medieval guilds. In 1611, Robert Baker, a tailor, purchased the land for £50. Baker purchased the adjacent plot to the East in 1622, which almost extended to the edge of what is now Rupert Street. The area is known as Piccadilly because of Baker. He built a house that became known as Piccadilly Hall, a derisive nickname, as Piccadilly was a part of a round hem of a garment.

When Baker died in 1623, the property was left to his family, who passed it to one of the biggest land speculators in London, Colonel Thomas Panton. Panton, a friend of Charles II, initiated the redevelopment of the site by constructing new shops and houses under licence from the Crown. This development, incidentally, was supervised by none other than Sir Christopher Wren, then Chief Surveyor of buildings for the Crown. After Panton's death, his daughter, Elizabeth, married Henry Arundell, the Fifth Baron Arundell of Wardour. In fact, the property then remained in the Arundell Estate until 1919.

There is no lack of excitement (and world firsts) for the estate. Once upon a time – in the mid eighteenth century, actually – the area was the home of a real tennis court, and it was this sporting and entertainment link which has survived through the ages. During the 1820s for example, the former tennis courts were used for the staging of theatrical performances, a circus and various exhibitions. There is, however, one historical blemish. In 1849, the property was known as The Argyll Rooms, offering Victorian Society an unprecedented



combination of casino and nightclubs. Its dubious reputation led to its closure in 1878.

That original cost of £50 has somewhat escalated today. The present owners of the Trocadero site are Trocadero plc, who value the development at some £330m, having paid £94m for the area in 1994. It was clear to the developers that there was considerable scope. "The site, which could easily boast having the premier location in Europe with a footfall of 55 million people per annum, was under-utilised, lacking in direction and mismanaged." Trocadero as a shopping centre had failed, and the key to success was seen in its transformation into a premier entertainment destination. That scope extends to the creation of virtual reality adventures, adrenalin-pumping simulated rides, interactive exhibitions, a multi-screen movie house, and the latest in shops and restaurants, including the biggest HMV music store in London.

A Magic Formula

The vision is now about to become reality. In a joint venture, Sega Amusements, leaders in hi-tech in-house entertainment, is creating the world's largest futuractive indoor theme park. Accommodated in 100,000ft.^{2} (equivalent to 10 Wimbledon tennis courts or 753 London buses), the theme park spans seven floors connecting three buildings – itself a dynamic feat of engineering. Amid the 'mind-blowing fun and entertainment', there are six interactive virtual reality rides – never before seen in Europe. They include a variety of highly themed zones and a real life-size harrier jump jet. Confidence abounds, and the management expect at least 1·75 million visitors in the first year alone.

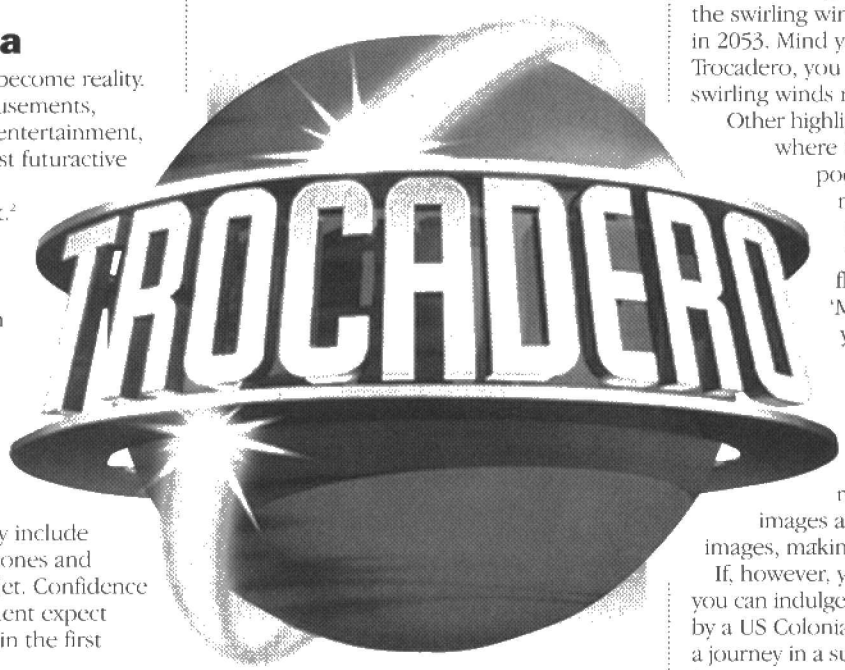
For the record, Segaworld is entered by a rocket escalator which boosts visitors up five floors at once, passing en route, the wrap around vidi-wall, and two huge telecom towers amidst an array of lights, lasers and special effects. The result is spectacular. For anyone of less visionary build, there are some 19 more conventional escalators. The six main rides are Beast in Darkness; Space Mission; Aqua Planet; Ghost Hunt; Mad Bazooka; and ASI – Simulator. Something there for every taste. Meanwhile, the six themed zones cover Sports, Flight Deck, Race Track, The Carnival, Sega Kids and Combat Zone. Each themed zone, apparently, will have its own vision, hearing and smell.

In order to house the Segaworld attraction, Trocadero plc set about creating a hi-tech experience. One which would visually mesmerise a visitor to the complex and also break away from the traditional 'heritage' offering more commonly associated with London. Top US architects, RTKL were commissioned to design a spectacular physical environment – whilst keeping the complex open to the public during the redevelopment. This included the acquisition of The London Pavilion cinema, a building which already housed The Rock Circus, allowing a direct link in Piccadilly Circus Metro station.

The new environment is totally controlled, which allows the Trocadero to change the ambience according to the mix of visitors on site: Families and children by day, and young adults and couples in the evening.

Entertaining Complex

The central atrium area in the Trocadero has been extended to the full height of the building, over 40m (130ft). high in total. Midway up this enormous expanse is a viewing platform for Europe's largest video wall, made up from 2·74 × 1·27m (108 × 50in.). TV screens and occupying



a space equal to three double- decker buses standing end-to-end. A four minute multi-media show will be screened every hour and will introduce a cast of alien characters whose threatening ranks include T-roc, Tech-Troc, Star-Troc and the real baddy, Trocadilla.

The Future is 3D

Next spring sees the opening of the stand-alone IMAX 3D Cinema at the Trocadero. Here, you will be able to take part in an 'unparalleled cinematic experience' which embraces the most innovative and exciting motion picture and sound systems in the world. Stereoscopic images are projected onto a giant rectangular screen (the size of two tennis courts) and the experience is complemented by a six-channel, Hi-Fi sound system. The audience will wear cordless electronic 3D headsets. Synchronised with the projector via an infra-red signal, the headsets work as electronic shutters, decoding the left and right eye images at 48 times per second. The effect suggests the designers will give an unparalleled 3D cinematic experience, where images lift off from the screen and audiences become so immersed in the action of the film that they interact as part of the movie.

Already booked are two internationally acclaimed movies, *Wings of Courage* and *Across the Sea of Time*. The 302-seat auditorium will have specifically designed seats for the disabled.

Enter the Virtual World

So, what else awaits your delight? Well, for a start, there is the 'world's' first digital theme park. Virtual World invites you and seven others to pilot your craft to a variety of exciting destinations. As Sports Warriors in Battletech, you enter a war zone on Planet Solaris VII, where you take control of futuristic two-legged tanks or test your skills in Red Planet, where you race your vehicle through shuttered mines to avoid the swirling winds on the surface of Mars in 2053. Mind you, when you exit the Trocadero, you may have to face the same swirling winds raging around Piccadilly. . . .

Other highlights include The Emaginator, where strapped in four seater pods, visitors not only see movies but experience them. Or there is Virtual Glider, which plunges you in a flight of fantasy over 'Metropolis' or challenges you to steer your way through the Grand Canyon in a VR hang-gliding experience. Using Liberty Image Generators, visitors 'enjoy' high-resolution real-time images as opposed to pre-set video images, making each experience special.

If, however, you are not keen on heights, you can indulge in Alien War, where escorted by a US Colonial Marine, you embark upon a journey in a subterranean world of fear and fantasy. Again, visitors play a participating role. Then, there is the Internet, where at a touch of a web-site button, visitors can surf Attractions of London.

Security and safety are no less hi-tech. A team of dedicated security officers supported by CCTV surveillance coverage both inside and outside the complex are on constant lookout. In case of power failure, there is a back-up generator on site. As there is no generator available which could possibly supply the Trocadero with enough emergency power supply (equivalent to the demands of a small town in the UK), the generator only provides emergency lighting and power to life-safety systems.

With the promise of the introduction of one new major hi-tech attraction every year, the future seems to be clearly marked 'The Trocadero'. ELECTRONICS

Trocadero Information

The Trocadero complex is open daily (not Christmas day) from 10.00am to midnight. For ticket details, Tel: (0171) 439 1791.

PROJECT

Liquid Level CONTROLLER

PROJECT RATING 1

Kit Available
Order as 95210
Price £12.99

FEATURES

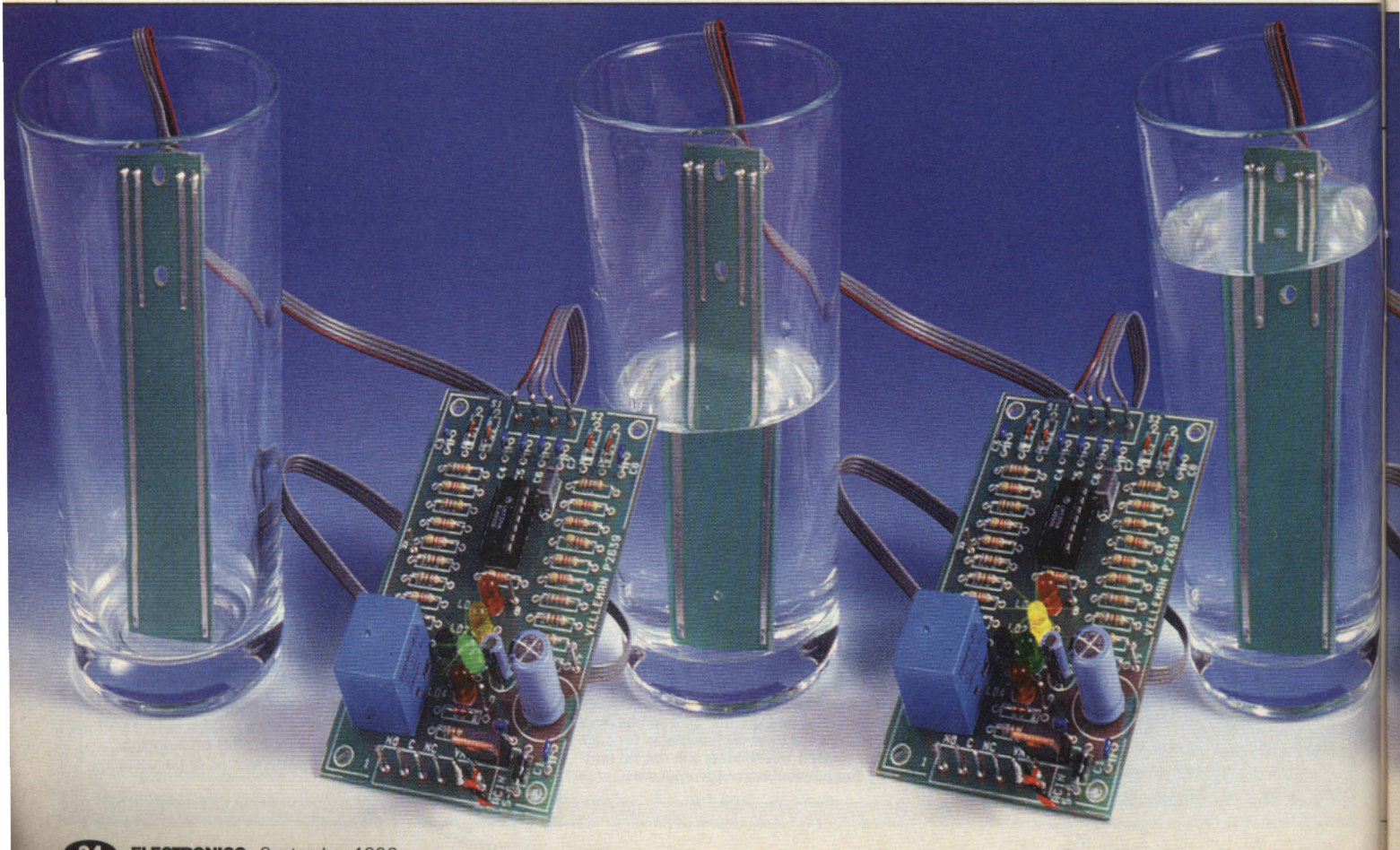
- 3-LED liquid level indicator
- Switched relay output with LED indicator
- AC or DC operation
- Remote sensor

APPLICATIONS

- Domestic sinks and baths
- Aquariums
- Rainwater butts/garden irrigation tanks
- Animal drinking troughs
- Water tanks

Text by Maurice Hunt

Avoid the potentially disastrous situation of water overflowing or leaking when filling up containers in the home (such as when running the bath), workplace or outdoors, by using this handy project to remotely indicate the current liquid level by means of coloured LEDs. The circuit also includes an on-board relay, which triggers when the highest liquid level indicator lights, and turns off again when the liquid level falls beyond a set level. The project can hence be used to activate an alarm, shut-off valve or pump when the container is full, or indeed, when it is almost empty. The project is capable, therefore, of being used as part of an automatic liquid level maintaining system.



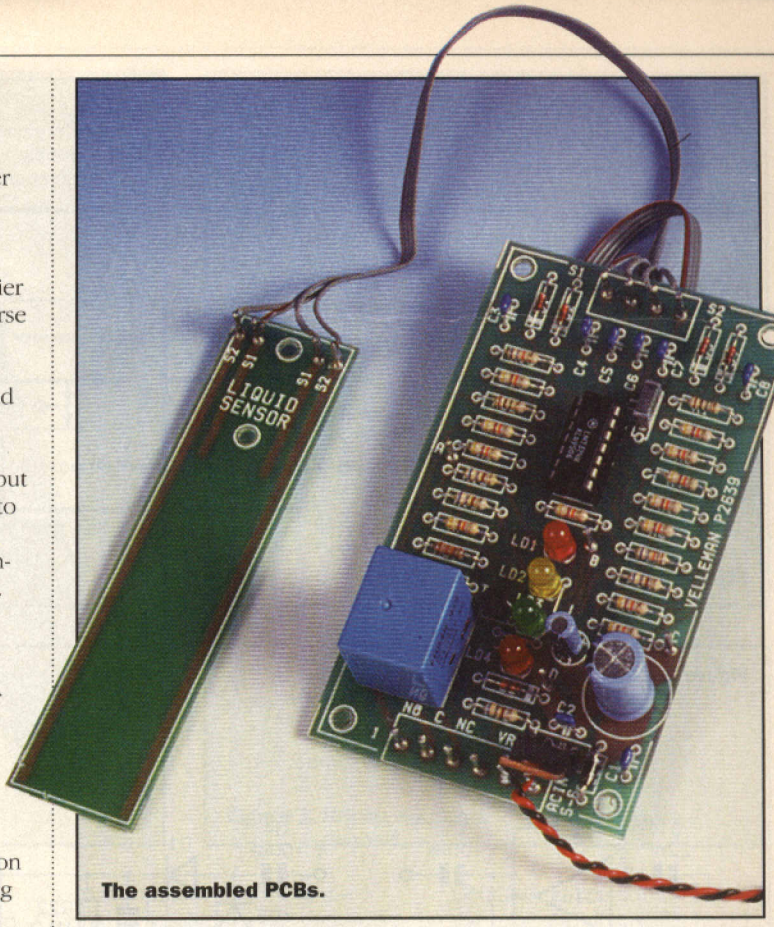
The Liquid Level Controller has many applications around the home, garden or in the workplace. Popular examples include monitoring the running of a bath while you concentrate on more important matters, an automatic aquarium topping-up system, plant irrigation, flood detection, rainfall monitoring, checking the level of water in a vehicle's windscreen washer bottle/header tank, in fact, almost anywhere that water is being contained and where the level needs to be kept in check. The circuit may also be interfaced to a computer if required, by means of the optional K2611 input card (Order Code 95207).

The kit contains all parts needed to build the Liquid Level Controller, including high quality glassfibre main board and liquid level sensor PCBs, on-board relay (with single pole, double throw – SPDT – mains rated contacts) and connection terminal pins. However, a suitable power supply will be required (see Specification table), in addition to connection cables of the required length and current rating for the chosen application.

Circuit Description

Refer to the block and circuit diagrams, shown in Figures 1 and 2, respectively. The power supply to the circuit may be DC or AC as stated in the Specification table, and D6 acts as both a half-wave rectifier (for AC supplies) or as a reverse polarity safeguard for DC supplies. C10 smoothens the half-wave rectified voltage, and acts as low-frequency decoupling if a DC supply is applied. VR1 regulates the input to give a stable 12V DC level to supply the rest of the circuit, while C1 and C2 provide high-frequency supply decoupling.

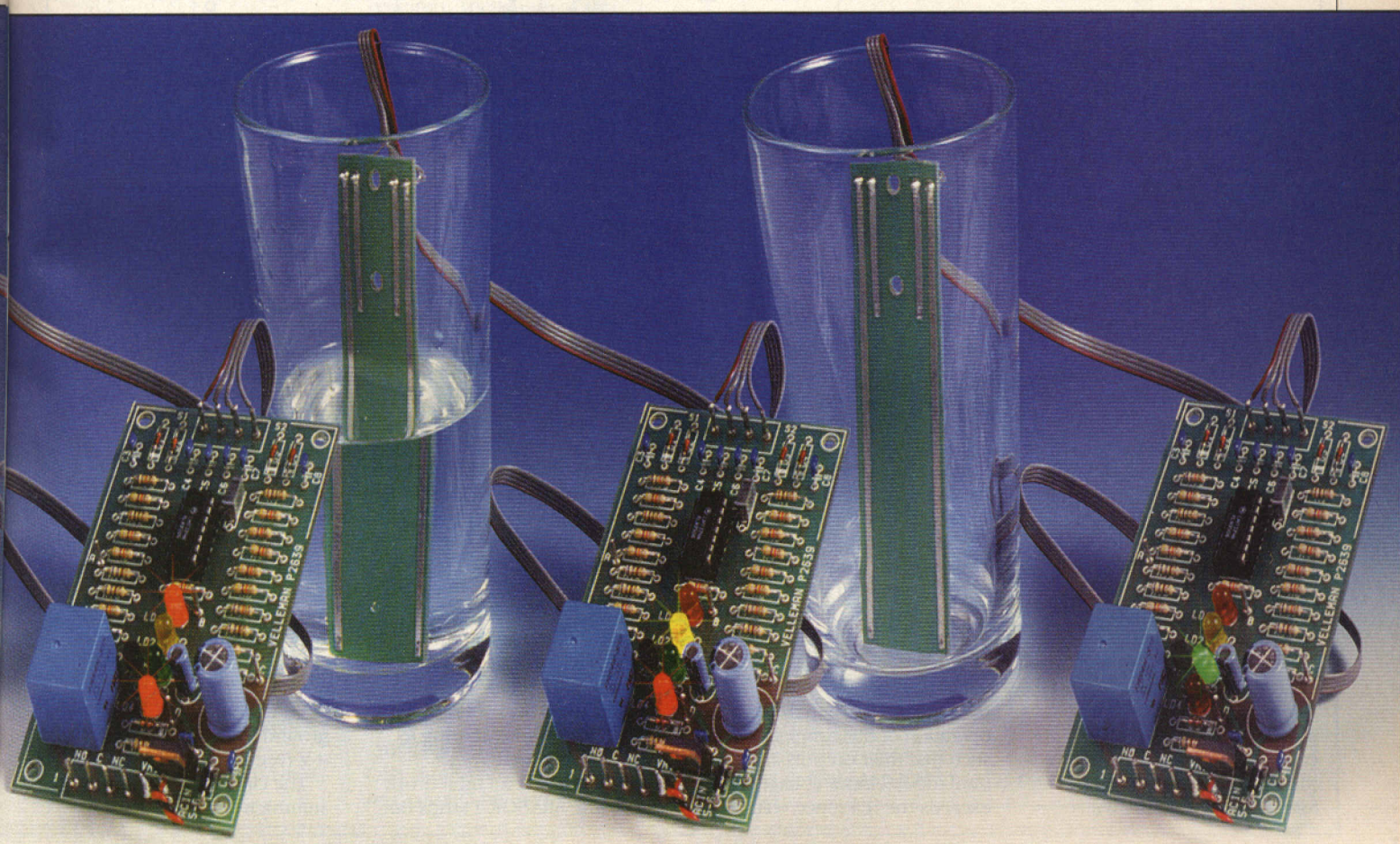
IC1 is a quad operational amplifier, all four of its amplifiers being employed in this circuit. The first amplifier is configured as an oscillator, generating a square wave signal of approximately 1kHz. This is passed via coupling capacitors C5 & C6 to the liquid level sensors. The reason behind applying an alternating signal to the sensors is to prevent the electrolysis effect that would otherwise occur if a DC voltage was present between the sensor terminals; this would lead to the build up of `gunk' on the strips on one side of the sensor, and possible erosion of the strips on the other side, with resulting unreliability of operation!



The assembled PCBs.

SPECIFICATION

Operating voltage:	12-14V AC (300mA minimum)
	or 16-18V DC (100mA minimum)
Operating current:	80mA mazimum
Relay output:	240V/3A AC or 125V/15A AC maximum
PCB dimensions:	104 × 60 × 23mm (assembled main board)
	104 × 25 × 1·5mm (sensor board)



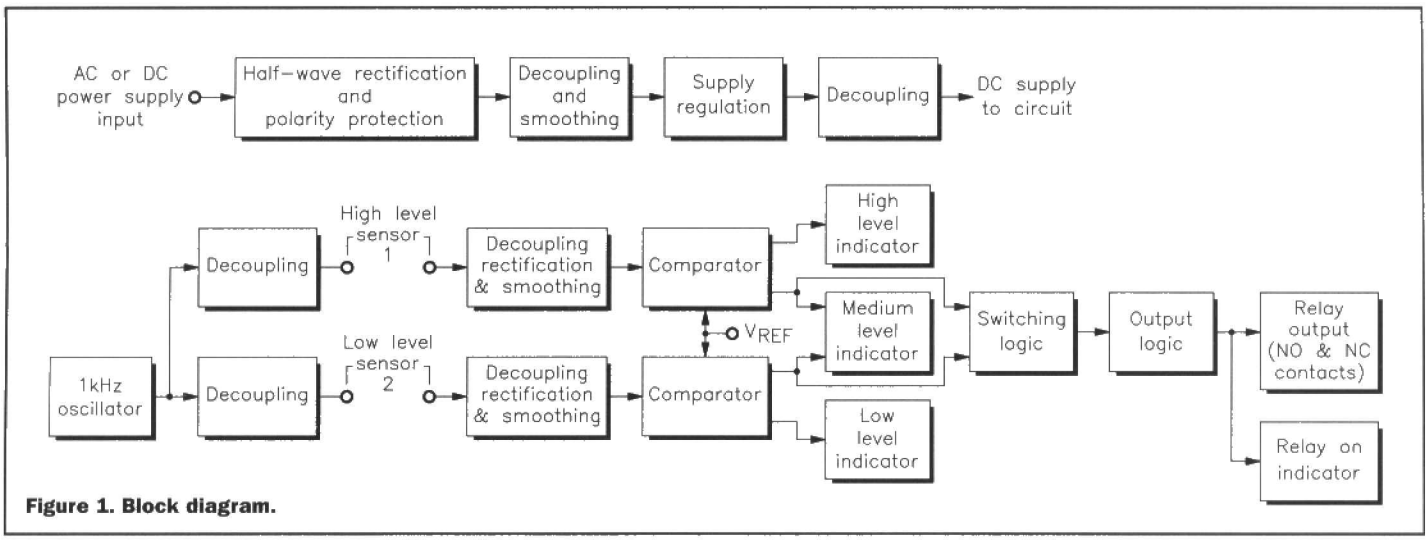
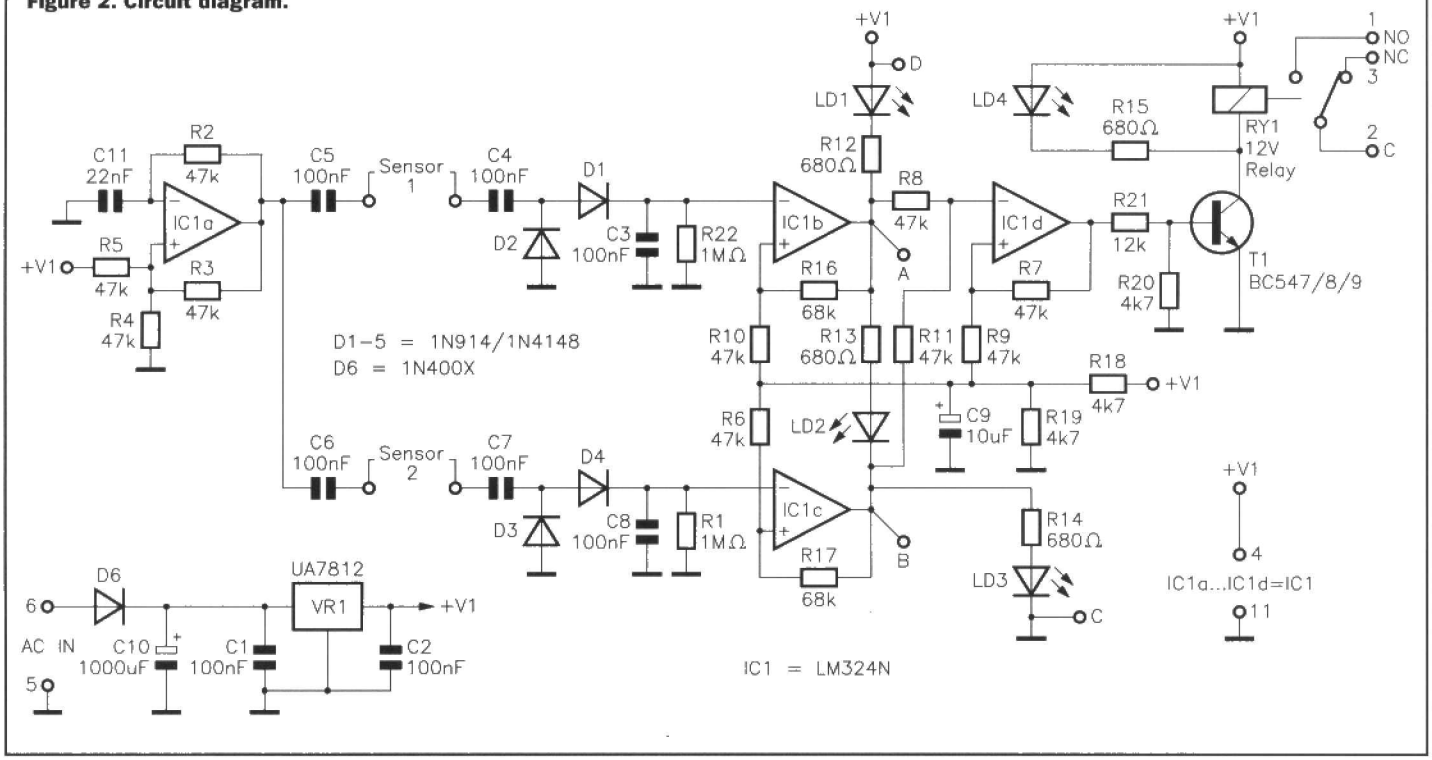


Figure 1. Block diagram.

Figure 2. Circuit diagram.



The sensors themselves comprise of parallel tinned copper strips on a separate PCB, approximately 1in. (25·4mm) long for S1 (the high level sensor), and approximately 4in. (101·6mm) long for S2 (the low level sensor). The length of these strips is unimportant – the sensor PCB can be cut down to size, or a new, longer sensor PCB could be fabricated and used instead, if required. However, the strips must be reasonably close together for the sensor to be effective – no more than an inch (25·4mm) or so apart. Note that the sensor is really designed for monitoring normal (tap) water levels; de-ionised water or other less conductive liquids may require the sensor strips to be closer together. Non-conductive liquids will not activate the circuit at all. There again, if measuring the levels of highly conductive 'liquids', such as Mercury, the strips could be yards apart and still allow successful operation!

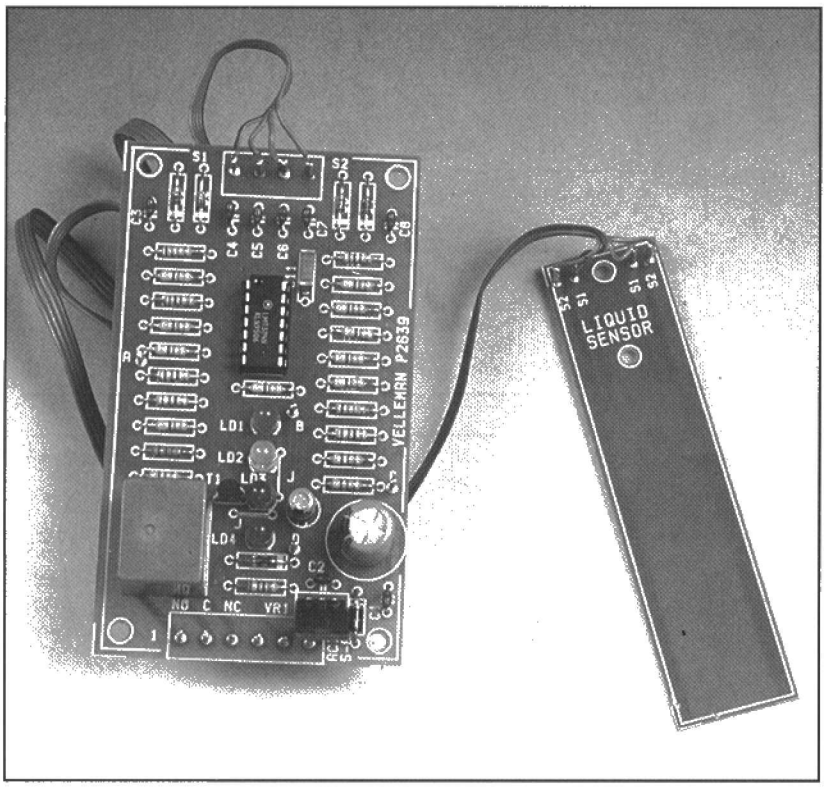
Capacitors C4 & C7 couple the signal passing across the sensor strips (in the presence of conducting liquid) to rectification and smoothing networks formed by D1, D2, C3 & R22 and D3, D4, C8 & R1. The outputs of these networks is in the form of two DC voltages, which are applied to two comparators, IC1b & IC1c. The reference voltage for the comparators is set by the resistors R6, R10 & R18. The operation of the comparators is such that their outputs are high until the DC input voltage exceeds the reference voltage (which occurs if the sensor strips are in contact with water, whereupon the outputs swing low. While the output of IC1c remains high, LED LD3 (the LOW level indicator) lights. When the output of comparator IC1c swings low, LD2 (the MEDIUM level indicator) lights, and LD3 is extinguished. When the output of comparator IC1b swings low, LED LD1 (the HIGH level indicator) lights, and LD2 is then extinguished.

The purpose of the fourth op-amp, IC1d, is to act as logic, so that when the HIGH level indicator (LD1) lights, the transistor T1 goes on, in turn switching on RELAY ON indicator LD4 and energising the relay coil, thus causing its contacts to change over.

If the liquid level then drops below the SENSOR 1 strips but still reaches the (lower down) SENSOR 2 strips, the logic causes LD4 (RELAY ON) and LD2 (MEDIUM) to remain lit and the relay energised. However, if the liquid level drops further, causing both sensors to become dry, only LD3 (LOW level) lights and the relay (and LD4) are switched off.

Diode D5 protects the transistor and LD4 from the high back e.m.f. generated in the relay coil when it de-energises. Points A-D (corresponding to the PCB pins A-D) are used if the optional K2611 Input Card is to be connected to the circuit; A is the output of comparator IC1b, B the output of comparator IC1c, C is the ground connection, and D the +V (regulated) DC connection.

The circuit operation is summarised in Table 1.



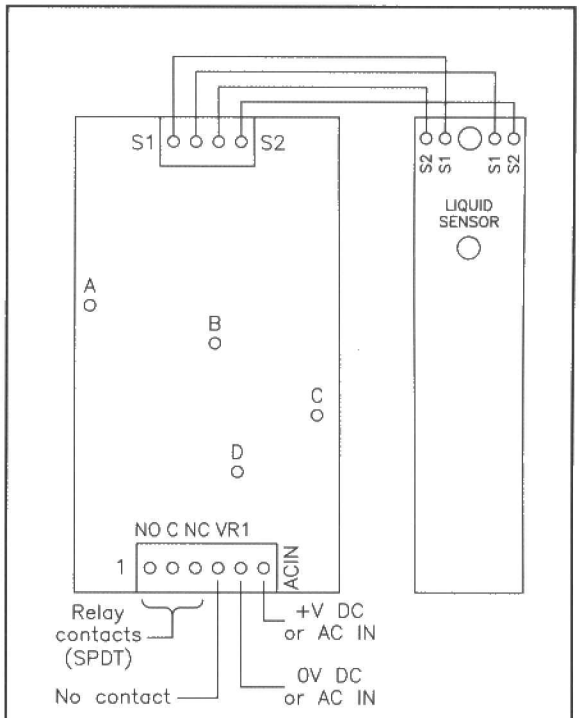


Figure 3. Wiring diagram.

Construction Details

The main board has a printed legend showing the position and orientation of the components. Assemble the board in order of ascending component height, starting with the resistors, diodes, and DIL holder (locating the end notch as per the legend). Progress through the smaller (non-polarised) capacitors, transistor, LEDs (using the colour order of your choice, noting that LD1 indicates the high level, LD2 medium, LD3 low and LD4 the relay on). Note also that the LEDs should be mounted at an appropriate height off the board, or could be mounted remotely if required, using hook-up wire to connect them to their contact points on the board.

Proceed to install the PCB pins (using the hot tip of a soldering iron to gently push them in if tight), then the taller electrolytic capacitors, voltage regulator and the relay. Install the IC into its holder last of all, with its end notch aligning with that of the holder/printed legend.

Additionally, there are four PCB pins to be fitted to the sensor PCB (if used). Having completed the board assembly, check your work for misplaced components, solder whiskers, bridges, or dry joints, then clean excess flux off the boards using a suitable solvent.

Testing and Use

Refer to the wiring diagram shown in Figure 3. Connect the sensor board to the corresponding S1/S2 terminals on the main board. The sensor board is fitted remotely from the main board, and is interconnected by ribbon cable or 4-way cable (e.g. telephone type cable), using suitable 4-way connectors if required. The length of this interconnecting cable is unimportant (within reason!).

Apply either an AC or DC supply of the correct voltage (see Specification table) to the main board; if DC, the '+' connection is to the pin nearest the legend 'AC IN', and the 0V connection is to the pin next to it. If using an AC supply (such as a 300mA transformer), connect the secondary winding to the same pins as above – it does not matter which way round.

With power on (and both pairs of sensor strips dry), LD3 (the LOW level indicator) should be lit. Using either a wire link or by placing the sensor into a beaker and adding water, bridge the longer SENSOR 2 (S2) strips. LD3 (LOW level) should be extinguished, and LD2 (MEDIUM level) should now light. Now add another link, or top up the beaker with water, so that both sensor strips (S1 & S2) are bridged. LD1 (HIGH level) and LD4 (RELAY ON) should now be on, and the relay should be heard to click, confirmation that its contacts have changed over. A continuity tester could be used at this point, to check that the relay normally open (NO) contacts have now closed, to be doubly sure.

Now remove the link across S1 (the shorter sensor strips) or drain off the appropriate amount of water from the beaker using a syringe/syphon. LD2 (MEDIUM level) and LD4 (RELAY ON) indicators should be lit. Next, remove the link across the S2 strips/empty the beaker, and LD3 (LOW level) should light, and LD4 (RELAY ON) should be extinguished – the relay should also be heard to click off.

See Table 1 for clarification of the correct circuit operation. If the circuit operates as above, then it is ready for use in the chosen application. It is advisable to install the main board into a suitable sealed plastic housing to protect it – this is a MUST if an otherwise unhoused mains AC transformer is supplying the power to the circuit, or if the relay is being used to switch high voltages.

Sensor 1	Sensor 2	Output	Indication
DRY	DRY	LD3 lit	LOW liquid level
DRY	WET	LD2 lit	MEDIUM liquid level
WET	WET	LD1 & LD4 lit	HIGH liquid level; relay energised
DRY	WET	LD2 & LD4 lit	MEDIUM liquid level; relay remains energised
DRY	DRY	LD3 lit	LOW liquid level; relay de-energised

Table 1. Summary of circuit operation.

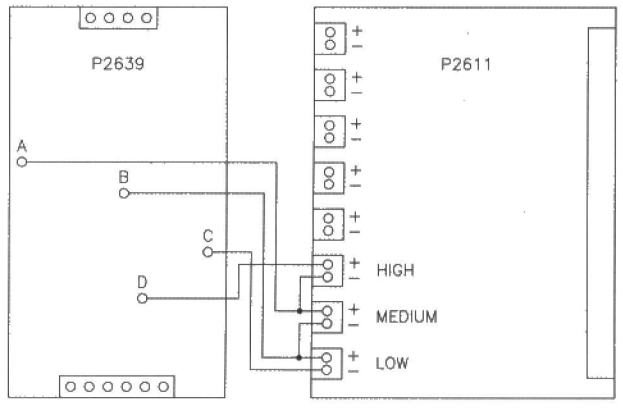


Figure 4. Wiring to K2611 Input Card.

Computer Aided Level Control

Figure 4 shows how the Liquid Level Controller can be connected to the optional K2611 Input Card (95207), to allow the unit to be interfaced to a computer. This enables the computer to be utilised to monitor liquid levels and control them efficiently. If the computer is supported by the Velleman Interface System (95208 & 95209), the K2611 Input Card can be connected via a motherboard.

Connections A-D on the main Liquid Level Controller board should be connected to the card as indicated in the diagram. Connect B with the '+' of optocoupler input 1 (LOW), and C with the '–' of input 1. Connect A and B with the '+' and '–' inputs, repectively, of input 2 (MID). Connect D with the '+' of input 3 (HIGH), and A with the '–' of input 3. If an optocoupler input appears to remain permanently high, a 3 to 6V Zener diode should be connected in series with the + of input 3. If higher resolution is required, additional Liquid Level Control units can be added to detect more than three levels.

ELECTRONICS

Important Safety Note

NEVER use the sensor in an environment containing explosive gasses; when the sensor strips are dry, it is possible that very small sparks can occur on them, which could ignite pockets of combustible gas with a resultant explosion. In a chemical environment, the metal sensor electrodes can erode and/or corrode – in this case, the sensor electrodes should be formed from inert metal, e.g. inoxidable steel (inox). Take all the usual mains safety precautions if using a transformer to power the project or if the relay is being used to switch mains voltages. If in doubt, consult a qualified electrician.

PROJECT PARTS LIST

RESISTORS: All 0·5W ±5% Metal Film

R1,22	1MΩ	2
R2-11	47k	10
R16,17	68k	2
R12-15	680Ω	4
R18-20	4k7	3
R21	12k	1

CAPACITORS

C1-8	100nF Polyester	8
C9	10µF 35V Radial Electrolytic	1
C10	1,000µF 25V Radial Electrolytic	1
C11	22nF Polyester Layer	1

SEMICONDUCTORS

D1-5	1N914/1N4148	5
D6	1N400X	1
T1	BC547/8/9	1
VR1	UA7812	1
LD1-4	5mm LEDs (2 × Red, 1 × Yellow, 1 × Green)	4
IC1	LM324N	1

MISCELLANEOUS

12V DC SPDT Relay, 15A@125V AC Rated Contacts	1	
14-pin DIL Socket	1	
PCB Pins	18	
Main PCB	1	
Sensor PCB	1	
Instruction Leaflet	1	
Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

K2611 8-channel Opto-coupler Input Card	1	(95207)
K2612 Intelligent Motherboard	1	(95208)
K2631 Extension Kit	1	(95209)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available in kit form only.

Order As 95210 (Liquid Level Controller) Price £12.99

Please Note: Some parts, which are specific to this project (e.g., PCB), are not available separately.

Stray Signals

by Point Contact

New Departures

Developments in the electronics scene promise better and cheaper service for the customer, in various spheres. My eye was caught the other day by a news item about 'Wireless Cable' which seems on the face of it, to be as nice an example of oxymoron as one could find. Although I suppose one type of cable, namely fibre optic, could be described as wireless, at least in the metallic sense – although it often also contains a metal wire as a strength member. No, what the term 'wireless cable' has been coined to describe, is a scheme being used by phone companies in the USA to compete with cable TV companies. Cabling residential areas is an expensive and time-consuming business. Bell Atlantic is using a 'wireless cable system' to pipe 33 analog 6MHz video channels in the 2·1 and 2·7GHz bands direct to customers' homes on a local area basis. Put up an antenna, and you can reach thousands of potential customers at much less cost than digging up the street to lay cables. Also dubbed horizontal DBS, it sends signals to receivers on the outsides of customers' homes, and like direct broadcasts from satellites, it is one way only – not interactive. Meanwhile, in the UK, lower bandwidth two-way wireless systems are appearing, offering yet another alternative phone service to customers, besides BT and cable. The first was launched in May, and others can be expected to follow.

The cable companies, on the other hand, can offer data rates for digital traffic that far outstrip what the telephone companies can offer. The domestic dial-up phone line can support only 28·8k-bps, even with the latest modems, whilst commercial premises with access to the ISDN (integrated services digital network) only benefit from a data rate of 64 or 128k-bps. By contrast, with the bandwidth available over the cable companies' networks, data rates of up to 27M-bps are possible. Only a few such systems are up and running as yet, even in the USA, and it may be some time before such facilities are available here. Meanwhile, in a move to improve international wideband data exchange, the G7 nations (Great Britain excepted!) have agreed to interconnect their broadband networks under the GIBN (Global Interoperability for Broadband Networks). Yet another example of the UK's genius for being left behind while the rest of the world progresses.

Running Repairs – à la Heath Robinson

PC's cassette player has been out of commission for ages, awaiting repair – an example of 'the plumber's tap always drips' syndrome. Eventually, he got around to it, and discovered that whilst the motor-to-capstan belt appeared to be in good order, the belt from the motor to take-up/fast forward and rewind pulleys (running in pulleys with a deep vee-groove) had, after some twenty years, perished and stretched. Phoning around likely suppliers elicited the fact that they all stocked video drive belts (and pulleys and heads, etc.), but none had any parts for the humble cassette recorder. What's more, a careful look at the transport mechanism showed that even if a replacement belt had been available, a good deal of tricky disassembly and reassembly would have been necessary in order to install it, as it passed around various parts of the mechanism, including the capstan spindle, which has bearings at both ends. So, the perished belt was snipped and withdrawn, and replaced with a length of shirring elastic, threaded through as necessary and drawn up fairly tight before being knotted! It actually worked on play, but the 'belt' slipped on fast forward or rewind. It was then replaced with two strands of the same elastic, drawn up a little tighter before being secured with a knot as before. The result appears to be complete success, with many hours of playing time clocked up to date. Even if it needs replacing occasionally, the job is simple, and it couldn't be cheaper. So, next time something needs fixing and you can't obtain the right replacement part, remember the Heath Robinson approach.

Excelsior – Ever On and Up

– Or in this case, down. PC has always had an interest in low distortion circuitry, even though not subscribing to the excesses of the golden ears brigade with their £1,000 speaker cables, etc. Just how low can you get the distortion in audio circuitry? Well, a recent advert for the Burr-Brown OPA132 op-amp claims a THD (total harmonic distortion) of 0·00008%.

I phoned up and verified that this is not a misprint, for the device is very modestly priced, and was assured that 0·00008% it is. This is beginning to get seriously difficult to measure, for even if all the distortion were concentrated in a single harmonic, the second or third say, it would still be no less than 122dB below the fundamental. In many cases, this is going to be at or below the noise floor of the measuring system, and finding a suitable test signal is also clearly not a trivial task. But if you thought that presents a difficult measurement problem, spare a thought for the OPA627, from the same manufacturer. Costing several times as much as the OPA123, it features a THD + noise specification of 0·00003% typical, at a gain of 1 at 1kHz!

Magic

While the performance of the OPA627 is remarkable, there is nothing magic about it, but you occasionally see performance figures quoted, which if taken literally, WOULD be magic. For instance, the 500MHz MAX4100 is advertised as consuming just 5mA – yet delivering 80mA! Of course, in fact, it doesn't manufacture any extra current; the 5mA quoted is purely the quiescent current, when not driving a signal into a load. Just another example of 'American specmanship'. However, there is an area of electronics which is regarded by many engineers (especially digital designers) as dominated by arcane magic, namely RF circuitry, but once the fundamentals are understood and appreciated, RF design is, in fact, relatively straightforward, especially nowadays, with spectrum- and network-analysers to hand. Having spent much of his working life earning his pittance in the field, the nearest PC found to anything magic is that handy tool, a tuning wand. For those unfamiliar with it, this is a useful accessory which I have never seen advertised – an RF engineer has to make his own. Typically, it consists of a few inches of insulating rod (for example, a broken bit of plastic knitting needle) with a small ferrite core fixed to one end, and a small bit of insulated brass rod to the other. Inserting the end into an air-cored tuning coil (or just bringing it near) will lower the tuned frequency (ferrite end) or raise it (brass end, by reducing the cross section of the flux path in air, increasing the reluctance). Of course, you must choose a grade of ferrite that is appropriate to the frequency at which you are working, so a selection of wands is often used.

Yours sincerely,

Point Contact

The Missing Link: ZEEMAN EFFECT

by Greg Grant

A century ago, the Dutch physicist, Pieter Zeeman, firmly established the connection between light and magnetism. Physics was in transition, tentatively edging away from Newtonian conviction, yet only leaning towards what would shortly become Planckian uncertainty. The Zeeman Effect was the blank page between both testaments.

In March 1862, the great Michael Faraday began work on his last experiment, an "...attempt to find the influence of a magnetic field on the light emitted by a source immersed within it."

He set out to observe a change in the position or width of the spectrum of a flame placed in the field of a powerful magnet. He was however, unsuccessful, because the spectroscopes of the day were simply not up to the task. Five years later, the Great Experimenter was dead, convinced to the end that such an effect would be found, for he looked upon the light as being universal in nature.

This had not been Faraday's first attempt to link light and magnetism. As early as September 1822, he had 'tested his expectation that electricity should alter the polarisation of a beam of light, and six years later, he experimented, again unsuccessfully, on the presumed influence of light on electricity.'

In 1845, he tried again, this time successfully – he discovered that a magnetic field affects the polarisation of light in crystals and, concomitantly, put forward the view that light could be waves of electromagnetism. His last experiment could be seen as an attempt to take this discovery further.

Enter Machinery

At this time, Spectrum Analysis, or the resolution of a beam of light into components that differ in wavelength, depended on prisms, as indeed, most investigations of light had done since Newton's day.

Diffraction gratings were known (the German optician, Joseph von Fraunhofer, had used one in place of a prism in 1820), but they only became practical in 1885, with the invention of the concave diffraction grating. The brainchild of the American research physicist, Henry Rowland, the new grating could be machine-made, the equipment for doing so being yet another of his inventions. The machine was capable of engraving some 20,000 lines to the inch, a development that removed the need for the usual additional components common in spectrometers, such as mirror and lenses. The concave grating gave all the sensitivity needed.

In the following year, Rowland mapped the solar spectrum using his concave grating. The result was the precise wavelengths of some 14,000 lines and his 'Photographic Map of the Normal Solar Spectrum' of 1888 was, in effect, a spectrogram greater than 11m in length! His Solar Spectrum Wavelength table contained tens of thousands of lines and remained the standard work on the subject for some years. Indeed, some of his gratings are still in use.

In 1895, Hendrik Lorentz, the Professor of Physics at Leiden University in the Netherlands, began to consider if the electric charges within the atom itself could oscillate. He thought that if they could, then they could be observed by experiment.

Lorentz was not alone in this view. The British theoretical physicist, Joseph Larmor, had already put forward a similar theory, but shortly abandoned it after calculating that the oscillations (if any) would be too small to measure. Lorentz however, was not so sure, and asked his assistant, Pieter Zeeman, to look into the matter.

The Link Revealed

The son of a Lutheran minister, the 31 year old Zeeman had studied under both Lorentz and Kamerlingh Onnes. In 1893, he had been awarded his doctorate for his thesis on the Kerr Effect, a dissertation which also won him a gold medal. He took up Lorentz's suggestion "...feeling that if Faraday had thought the experiment worth doing, it might be worth repeating with better, more sensitive apparatus."

Figure 1 illustrates Zeeman's technique. A sodium flame was placed in a powerful magnetic field and observed via a diffraction grating. Zeeman used a Rowland grating with a 10 foot radius and discovered that the sodium's yellow D-lines broadened, then parted into patterns of a few lines each as the field strength increased. He subsequently found that the broadening was a distinct splitting of the lines into as many as 15 components.

In Figure 1a, the light is received in a direction parallel to the field, the Longitudinal or Parallel Effect, viewed through a hole bored in the pole-piece; the lower pair of lines replace the original line when the field is switched on. These lines are circularly polarised in the opposite sense, as shown, and both lines each account for half the energy of the original.

In Figure 1b, the light is received across the field, the Transverse or perpendicular Effect. Here, the original line has been replaced by a triplet and the original energy is now apportioned frictional, namely ¼, ½ and ¼, giving equal amounts to polarisation in each direction. This is termed the NORMAL Zeeman Effect and is explained as the speeding up and slowing down of orbital electrons in the field source as a consequence of the applied magnetic field.

The ANOMALOUS Zeeman Effect, on the other hand, is more complex, splitting the lines into several *very* closely spaced ones.

It is termed anomalous because it does not agree with the predictions of classical physics, and is explained by quantum mechanics in terms of electron spin.

In 1896, however, matters were different. To begin with, the electron had yet to be discovered, although its charge had been estimated, and its name introduced, five years earlier by the Irish physicist, George Stoney.

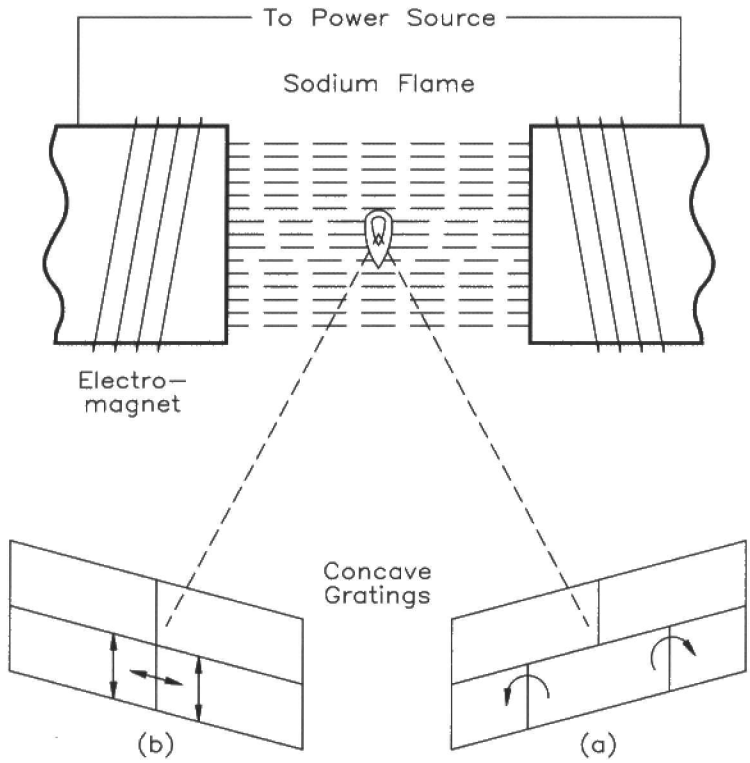


Figure 1. The Zeeman Effect, illustrating the Longitudinal and the Transverse aspects.

Furthermore, seven years before Stoney's farseeing prognosis, the Swedish chemist, Svante Arrhenius, suggested that atoms or groups of atoms could carry electric charges. Lorentz favoured Arrhenius's theory and suggested that light resulted from what he termed the motion of charged particles within the atom. He then used Zeeman's discovery, the behaviour of light in a magnetic field, to calculate the mass/charge ratio of such a charged particle. And this, a year before the electron was discovered and some 15 years before the scientific community confirmed that the electron was indeed part of the atom!

In the following year, Zeeman himself demonstrated conclusively that vibrating electrons were the cause of the line splitting, using the blue-green cadmium line.

Later experimenters studying the Zeeman Effect used electric discharge tubes, which emitted a bright-line spectrum between the magnetic poles. Diffraction gratings too, were improved. Manufactured from speculum-metal as well as glass still, they carried a very considerable number of lines, of the order of 1,000/mm.

Later, the Danish physicist, Noels Bohr, in five papers published from 1913 to 1915, proposed that the vibration was, in fact, electrons changing from one discrete energy level to another, each of these levels being split in a magnetic field into substrates of equal energy. In other words, the Zeeman Effect is the result of the outermost atomic electrons interacting with the magnetic field, and what had been a single spectral line without the field, became two or more under its influence, the frequency of spacing between the lines depending on the field strength.

The Zeeman Effect is important in modern science, since it helps physicists to determine the energy levels in atoms and identify them in terms of angular momenta. It is also used in the study of electron paramagnetic resonance.

In astronomy, the Zeeman Effect proved its usefulness as early as 1908, when the American astronomer, George Ellery Hale, discovered magnetic fields in sunspots through observing the splitting of spectral lines.

The Zeeman Effect is still a powerful astronomical tool today, enhancing the study of not only our own sun, but also the magnetic fields of other stars.

The Zeeman Effect was a point between the visualisation of phenomena possible with Newtonian mechanics and the wave of probability likely with Quantum mechanics.

What had begun as a missing link was discovered to be a bridge spanning what was passing and what was yet to be. ELECTRONICS

Further Reading

From falling Bodies to Radio Waves, Emilio Segre, W. H. Freeman & Co., New York, 1984. Page 153.
Michael Faraday: Sandemanian & Scientist, Geoffrey Cantor, McMillan, Basingstoke, 1991. Page 233.
Michael Faraday, L. Pierce Williams, Chapman & Hall, London, 1965. Page 479.
From Compass To Computer, W. A. Atherton, San Francisco Press Inc., San Francisco, 1984. Page 221.

PROJECT

FEATURES

Low cost

Provision for optional ZIF socket

Visual indicators for power and programming state to PIC chip

APPLICATIONS

Experimenters and hobbyists

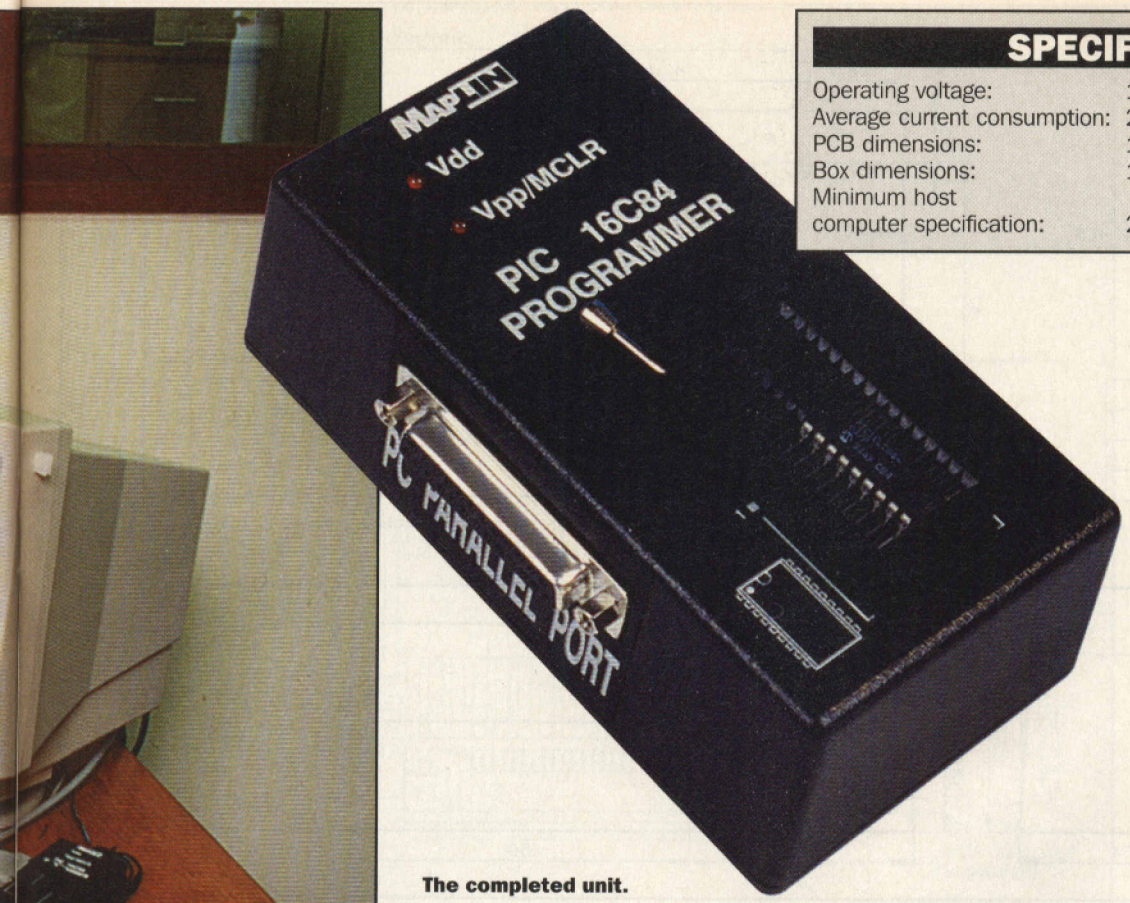
Development of PIC-based projects and circuits

Educational establishments

PIC 16C84 PROGRAMMER

Original design by David Tait, Maplin version by Chris Barlow
Text by Chris Barlow and Maurice Hunt

If you have an IBM-compatible PC with a parallel printer port meeting or exceeding the minimum stated specification, you can use it to program PIC16C84 microcontrollers by building this simple project.



The completed unit.

SPECIFICATION

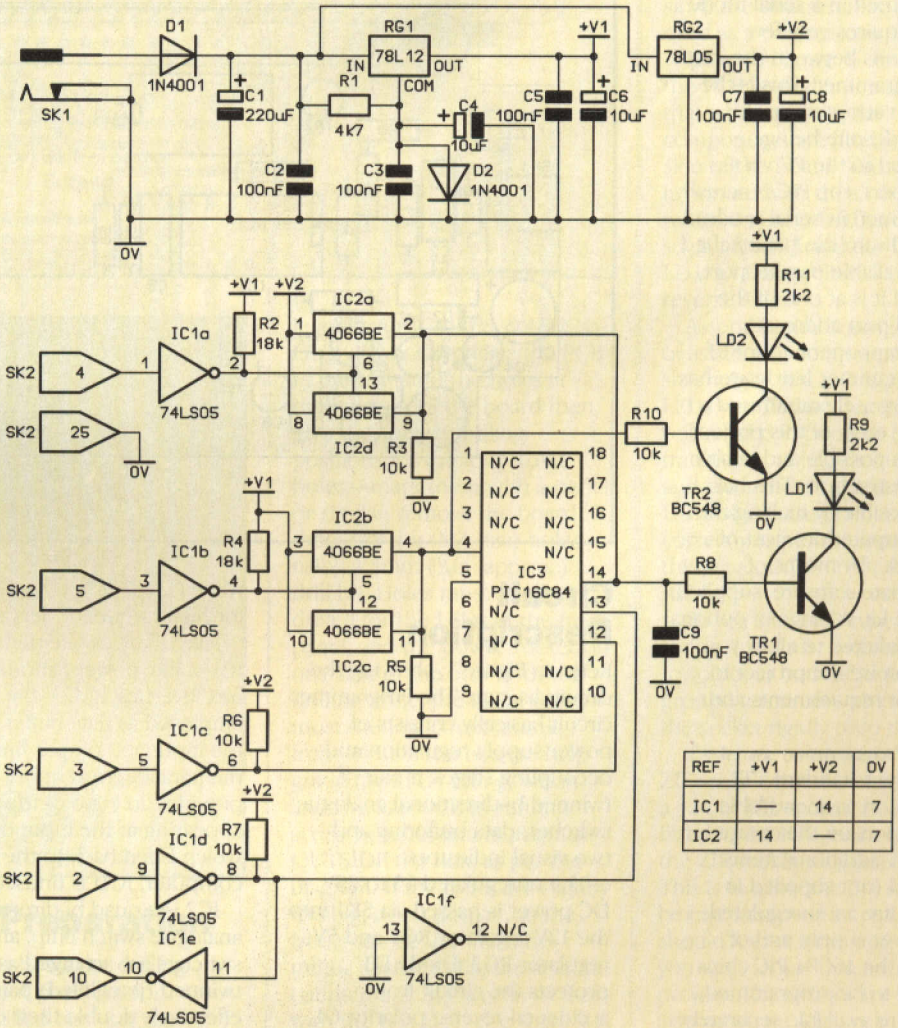
Operating voltage:	15-25V DC unregulated
Average current consumption:	25mA (during programming)
PCB dimensions:	119 × 57mm
Box dimensions:	130 × 68 × 46mm
Minimum host computer specification:	286, 386, 486 IBM-compatible PC

PROJECT RATING 1

Kit Available
Order as 95128
Price £19.99

The PIC 16C84 Programmer is designed to provide a very low cost introduction to DIY programming of the versatile range of PIC 16C84 microcontrollers, opening up enormous possibilities for the development of PIC-based projects, as well as being highly educational. Once you have learnt how to program these popular devices (and there's a vast information base to plunder in the form of books, magazine articles and Internet sites to help you do this), the PIC-based world is your oyster!

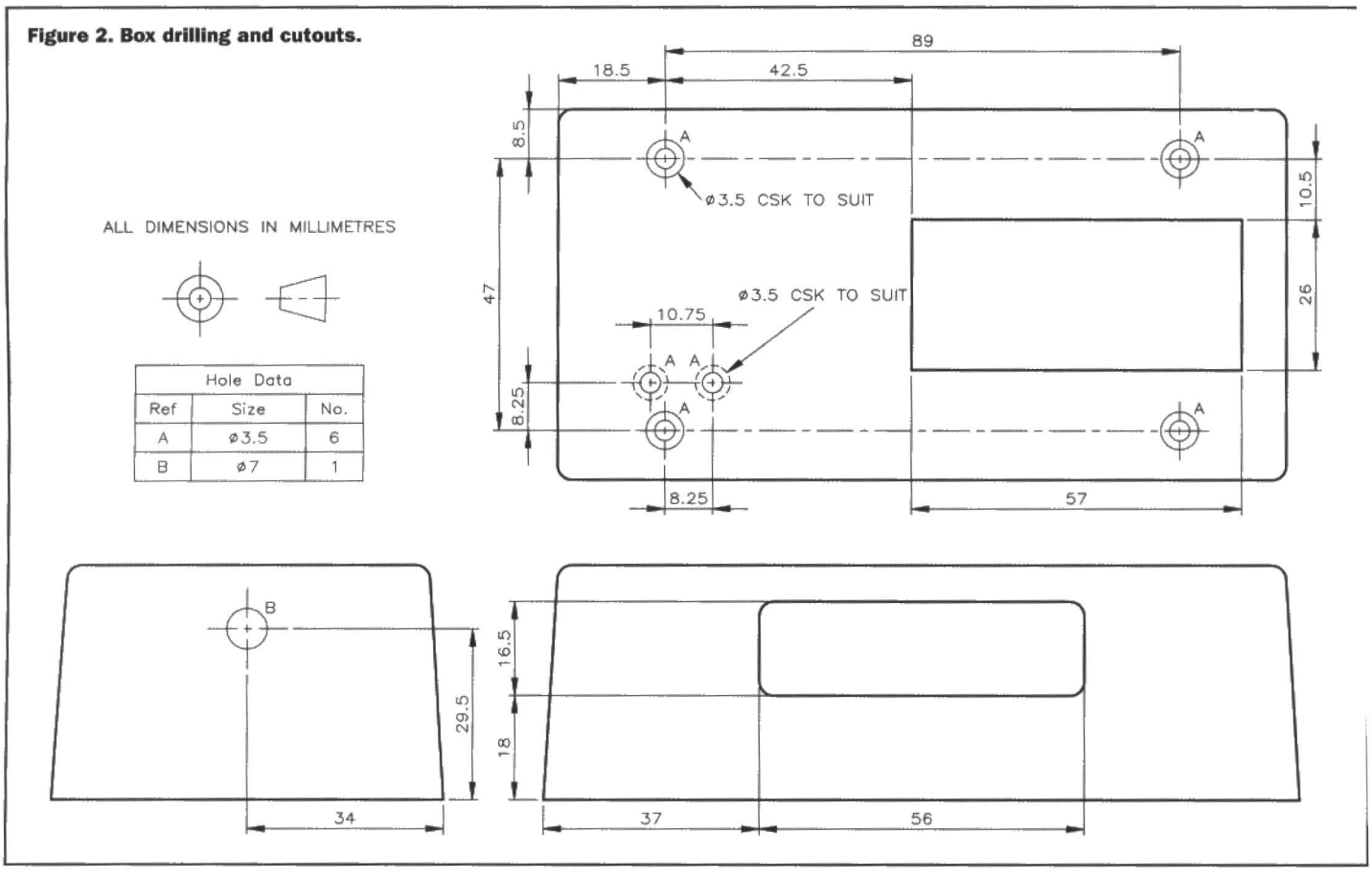
The PIC16C84 is a relatively recent addition to Microchip Technology Incorporated's range of microcontrollers (for which the name Peripheral Interface Controllers, or PICs was applied). The 16C84 s particularly useful, since its program memory is implemented in EEPROM (Electrically Erasable, Programmable Read Only Memory) technology. This gives the 16C84 a distinct advantage over conventional EPROM-type microcontrollers (and even other PIC varieties) during the prototyping stages of a project, because it can be reprogrammed virtually instantaneously (on average, it takes about 20 seconds).



REF	+V1	+V2	0V
IC1	—	14	7
IC2	14	—	7

Figure 1. Circuit diagram.

Figure 2. Box drilling and cutouts.



The 16C84 can be programmed in a serial mode which requires very few connections between the chip and programmer. This is the approach adopted for this project (despite being connected to the PC via a parallel port, the PIC is actually programmed in serial mode). The hardware can be attached to any available parallel port, provided it is at one of the standard port addresses.

The component count of the Programmer hardware has been purposely minimised to keep the costs of this project as low as possible and enable easy construction. This has been possible by making the host computer do most of the 'work', by means of appropriate software, supplied with the kit. A range of optional parts is offered to allow you to customise the project to suit your requirements and budget.

The Programmer uses a convenient standard TTL connection to an available printer port on the computer. The only additional items required (not supplied in the kit) are an unregulated DC power supply, and of course, the 16C84 PIC chips that are to be programmed, which are available separately from Maplin – see current Catalogue for details.

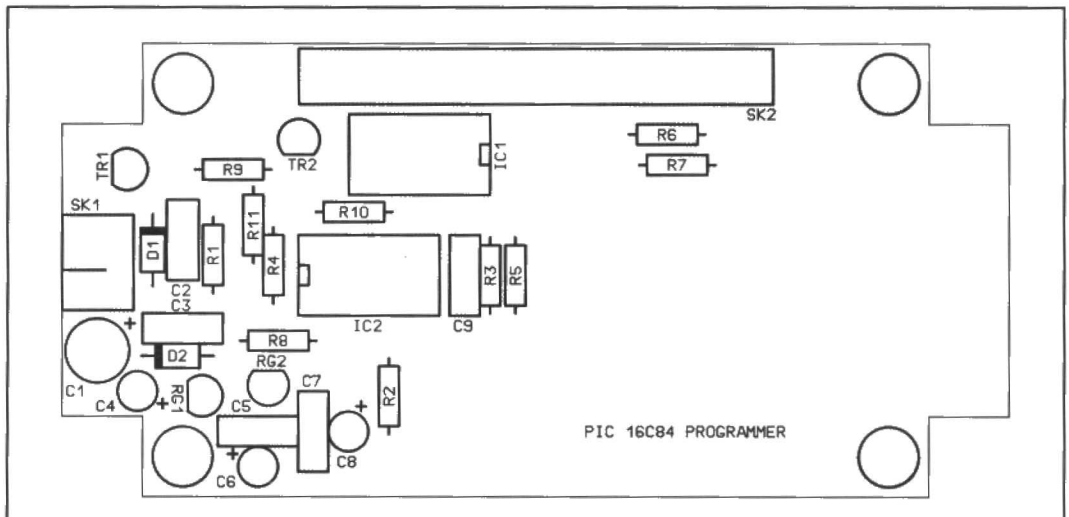


Figure 3. PCB legend and track.

Circuit Description

Refer to Figure 1, showing the circuit diagram. The Programmer circuit basically consists of power supply regulation and decoupling stages, a pair of twinned bi-directional analogue switches, data buffering and two visual indicators.

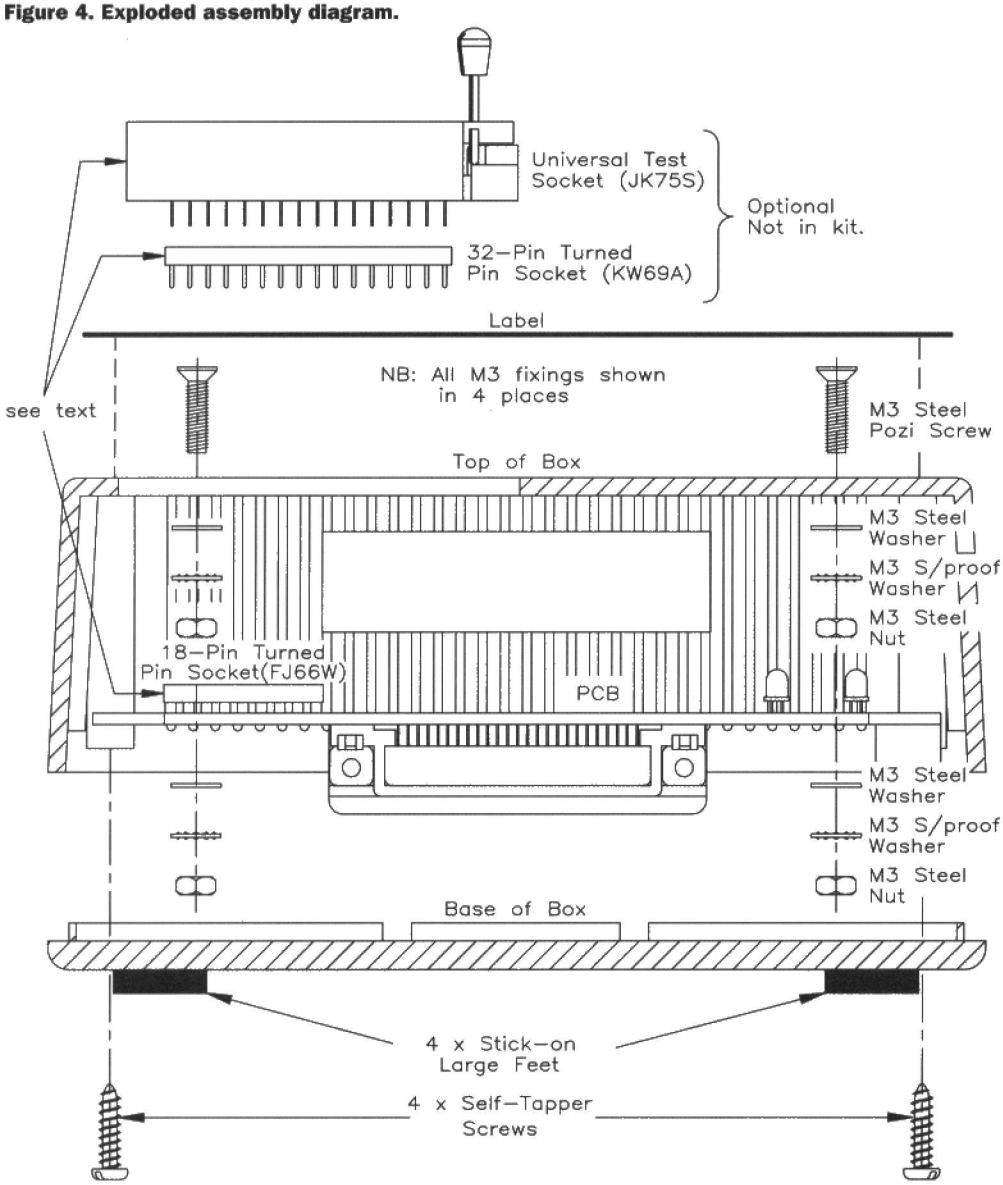
The unregulated 15 to 25V DC power is passed via SK1 into the 12V regulator RG1 and 5V regulator RG2. Diode D1 protects the circuit from accidental reverse polarity. C1, C4, C6 and C8 provide low frequency supply decoupling, while C2, C3, C5, C7 and C9 are for high frequency decoupling.

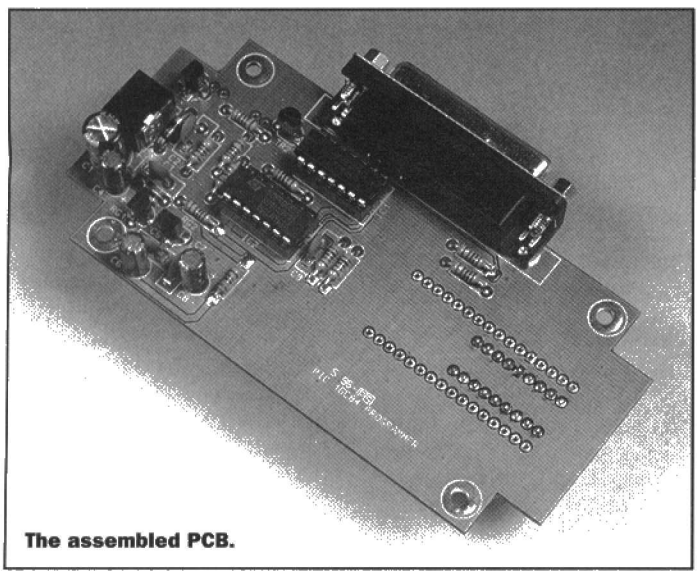
Five of the six elements of IC1, a low-power Schottky TTL hex inverting buffer chip, are employed as data buffers for the input and output lines on the parallel printer port. IC1e provides an echo of the signal appearing at the input of IC1d, which is fed back to the host computer. IC1f is unused.

IC2 is a quad bi-directional analogue switch chip, and the switches are arranged as twinned (paralleled) pairs, to effectively double their current handling capacity and halve their 'on' resistance. Their 'contacts' close when a logic '1' appears on their control input, which occurs when the inputs to IC1a & IC1b are low.

The outputs of the analogue switches are fed into the V_{DD} (+) and $\overline{MCLR}$ pins of the PIC to be programmed (IC3), and the states of these inputs are indicated by means of the transistor-driven LEDs, LD1 and LD2, respectively. The software thus controls when power is supplied to the PIC, so that it is only powered up during the programming duration, leaving it powered down (and therefore, safe to plug in and out of its holder) before or after programming it.

Figure 4. Exploded assembly diagram.





The assembled PCB.

The only other connections to the PIC chip are to pin 5 (V_{SS} or GND), pin 12 (RB6) and pin 13 (RB7). It is via the latter two pins that the programming data is serially fed into, through the buffers IC1c & IC1d.

Box Preparation

Figure 2 shows the drilling and cutout positions for the specified box. Lay the *unassembled* PCB into the box, so that the side printed with legends for IC3, LD1 & LD2 faces down. Centralise the PCB in the box, and the holes at each corner of the board then give the correct drilling positions for the four fixing holes – mark them with a pencil or similar, remove the board, then drill the (M3-size) holes using a 3mm (⅛in. approx.) drill bit. Holes must also be drilled for the LEDs in the front panel, and the power socket on one side of the box. With the drilling done, the LED holes must then be countersunk, from INSIDE the box (to help guide the LEDs into position), and the four PCB mounting screw holes countersunk from OUTSIDE the box, as per the diagram. If the holes are slightly too big, don't despair, as the labels can be used to hide minor mistakes! Ensure that the countersunk M3 screws sit flush with the box face, else there will be an unsightly bump (or dip) when the label is stuck on.

Use the relevant pre-punched labels (but DON'T stick them on yet), according to the type of IC holder you will be using for IC3 (DIL or the larger ZIF type), as templates to mark up the cutouts in the box. At this point, you can move onto the more interesting task, perhaps, of assembling the PCB, but return to read the final paragraph of this section when you have completed it, so that the box preparation may also be finished.

The next stage is to cut slots in the box to match the label cutouts. To do this, carefully drill a series of holes as close together as possible around the perimeter of the slot, use a blade/small saw (e.g. pad saw) to cut the slot, then use a flat file to tidy up the edges. Aim to make the slot slightly too small to begin with, and enlarge it to suit – regularly check for correct alignment using the assembled PCB as a guide. Now read the section entitled Final Assembly.

PCB Assembly

Do NOT build up the board until you have drilled the box, since the unassembled board is used as a drilling template.

Refer to Figure 3, showing the PCB legend and track. Note that while most of the components are fitted onto one side of the board (the side that is printed with their component reference), the DIL holder/ZIF socket for IC3 and the LEDs LD1 & LD2 are fitted on the reverse side.

Assemble the board in order of ascending component size/height, but DO NOT fit the LEDs yet. Ensure that the polarised components (diodes, transistors, voltage regulators and electrolytic capacitors) and DIL holders are orientated correctly as per the legend. At this stage, DO NOT fit the ICs IC1-3.

Fit the 25-way D-type socket facing outwards, and remember to solder in both of its end ground terminals – these hold the socket rigidly onto the PCB.

If you are using the optional ZIF socket with the Programmer, a 32-pin DIL socket should be fitted in the IC3 position, and the ZIF socket plugged into it. This is to allow the ZIF socket to be easily removed for replacement should it ever wear out, or if you wish to use it in another project. The DIL socket beneath also raises the ZIF socket so that it sits above the box, for easy access to the release lever.

However, if you do not wish to use a ZIF socket, use the 18-pin turned pin socket (supplied in the kit) in the IC3 position. Ensure correct alignment of the end notch.

It is inadvisable to retrofit a ZIF socket to a board that has had the 18-pin socket fitted, since the smaller socket would first have to be removed, which is likely to result in damage to the PCB tracks.

On completion of the PCB, check your work for misplaced components, solder whiskers, bridges and dry joints, then clean excess flux off the board using a suitable solvent.

Final Assembly

Fit the four M3 screws, together with nuts, washers and shakeproof washers as shown in the exploded assembly diagram, Figure 4. Place the assembled PCB onto them (angling it so as to pass the D-type connector through its slot in the side of the box), and check that the sockets align properly with the drilled holes and cutouts; use a file/drill as required to make adjustments as necessary.

Fit the LEDs into their holes on the PCB (observing polarity), but don't solder them in yet. Now install the PCB into the box (taking care to avoid the LEDs falling out!), secure it in place using shakeproof washers, washers and nuts, and manipulate the protruding LED leads until the LEDs fit into their holes in the box – push them in as far as possible. Next, solder the LED leads to the board, and trim the leads flush. The LEDs should now align with the holes in the box, even if the board is removed again for testing.

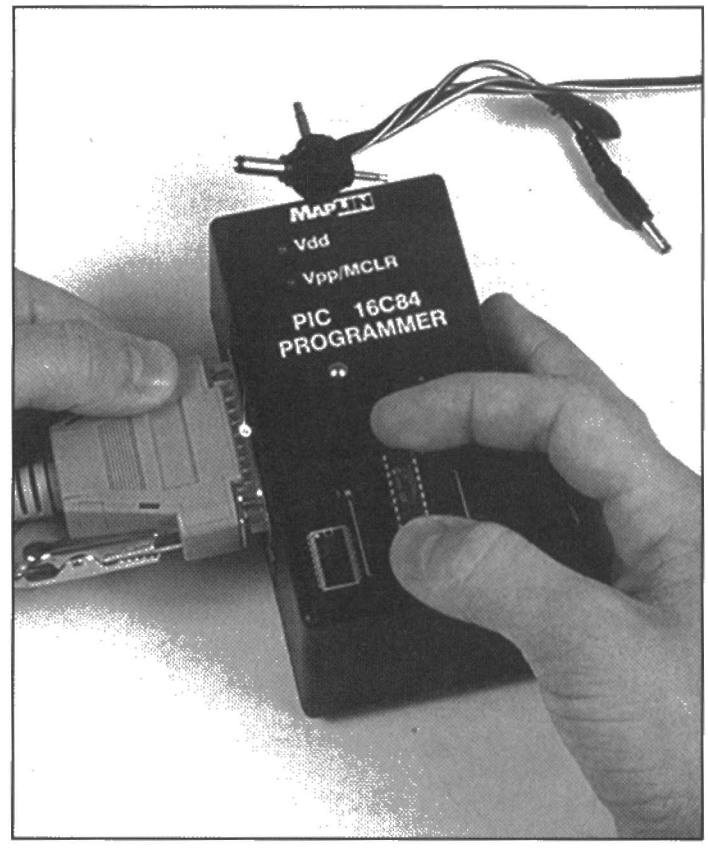
If everything fits in place as it should, wipe the box clean and apply the appropriate labels (see Figure 5). Fit the base onto the box with the four screws provided, and stick rubber feet onto each corner (leave the screws accessible, in case you need to remove the base in the future).

Initial Testing

Do NOT connect the Programmer at this stage. With ICs IC1-3 still omitted, connect a suitable power supply to the unit and test for the following voltage levels with respect to ground (e.g. available from the metal studs on the D-type connector):
Pin 1 of IC2 = +5V DC
Pin 3 of IC2 = +12·7V DC

Device	I/O pins/ features	EPROM words	RAM bytes	Max. clock speed (MHz)	Package	Order Code
16C84-04	13	1k	64+36	4	18-pin DIP	AY31J
16LC84-04	13	1k	64+36	4	18-pin DIP	AD53H
16C84-10	13	1k	64+36	16	18-pin DIP	AD50E

Table 1. Variants of the PIC 16C84 microcontoller.



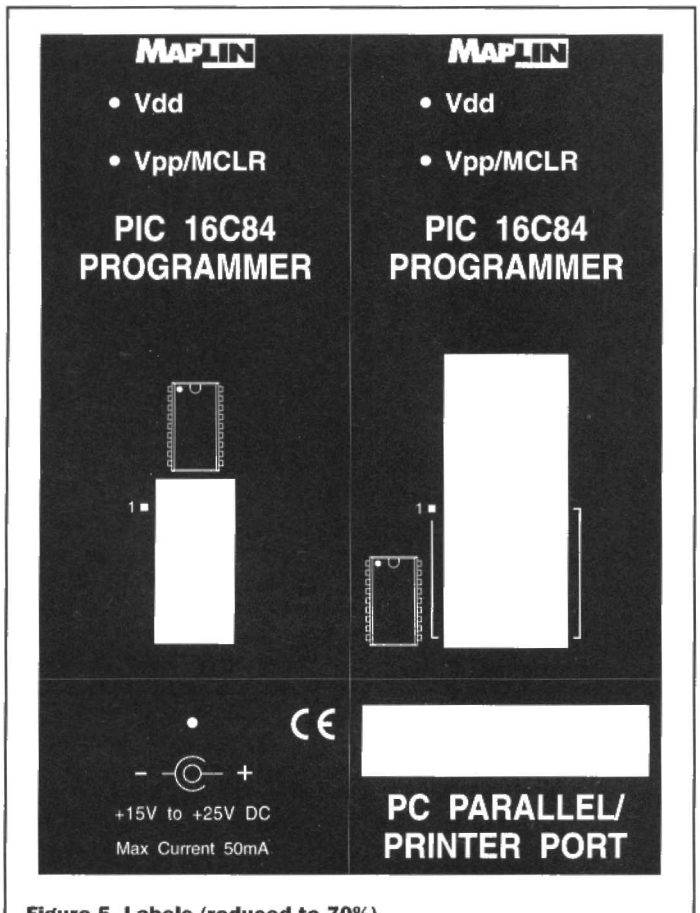


Figure 5. Labels (reduced to 70%).

Information requested	Example of input	Comment
LPT Port	1	(Available printer port on PC)
Hex Type	16	(Number of bits in the file, 8 or 16)
Program Hex File	a:\file.obj	(The hex file you wish to download)
Data Hex File	leave blank	(No data)
Osc: LP,XT,HS,RC (LP)	XT	(crystal-based clock)
Enable Watchdog Timer	Y	
Power-up Timer	Y	
Enable Code Protection	N	(If 'Y', the PIC code remains hidden)

Table 2. Programmer requested information.

Having confirmed these voltage levels to be correct, disconnect the PSU and insert IC1-3 into their sockets.

Testing in Use

Refer to Figure 6. Connect the PIC 16C84 Programmer unit to an IBM-compatible PC using a 25-way (Centronix type) cable between it and the computer's serial printer port. Connect a suitable power supply to the Programmer unit and insert the PIC microcontroller to be programmed into the socket, ensuring it is the correct way round (see Table 1, showing the various forms of PIC 16C84 microcontrollers available).

Install the software provided in the kit onto the computer's hard disk drive, while in the MS-DOS™ environment.

The file supplied on the software disk, pp.c, is no-frills Turbo-C software to control the programmer hardware. Alternatively, there is a QBASIC program, pp.bas, which is basically a translation of the C source. Read the comments in the programs for some instructions on their use. The file pp.exe is an executable version of pp.c.

Type **qbasic** at the hard drive prompt, i.e. **c:>qbasic**. With the software disk inserted in an appropriate drive, open up the file **pp.bas**, i.e. **a:\pp.bas**. Note, if this file will not run on your PC, instead, use the file entitled **ppnew.bas**.

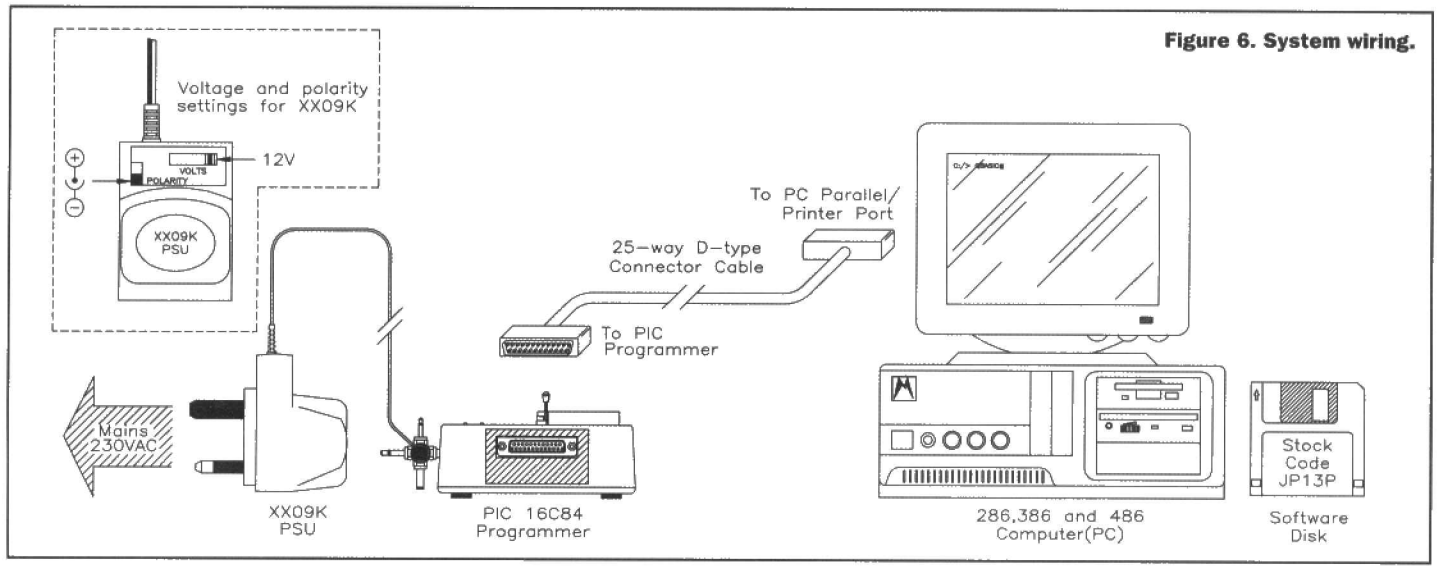


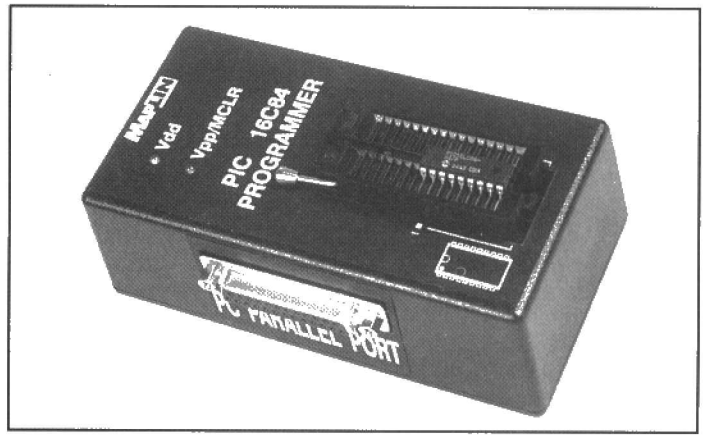
Figure 6. System wiring.

Start the program by selecting from the **qbasic** pull-down menu, and enter the information requested, see Table 2.

Once you have done this, and the computer has accepted the data you have entered (error messages will be displayed if there are any false entries or faults in the hardware connection or microcontroller), the system will then download the selected program into the PIC microcontroller. During programming, the two LEDs on the Programmer will be lit; the 'Vpp/MCLR' LED will go out first, followed by that marked 'Vdd', probably within about 20 seconds. Both LEDs are extinguished when the program has been downloaded and power has been (automatically) removed from the PIC microcontroller; ONLY then should it be removed from its socket, else damage may result.

If the ZIF socket is fitted, removal of the PIC microcontroller simply entails flicking up the release lever and lifting out the chip. However, an IC Extractor Tool (optional) should be used to unplug the PIC chip from the turned pin DIL socket, if fitted. Likewise, an IC Insertion Tool (optional) should be used to plug in the PIC chip, having pre-bent the pins using the IC Lead Straightening Tool (also optional). In each case, take suitable anti-static precautions before handling the device, for instance, wear an earthed wrist strap (once again, see Optional Parts List), or discharge yourself by holding an unpainted metal cold water pipe or similar. ELECTRONICS

Check out this ftp site: **ftp.mcc.ac.uk/pub/micro-controllers/PIC/**. If you are using a web-browser use the following URL: **ftp://ftp.mcc.ac.uk /pub/micro-controllers/PIC/**. Try this web page to find links to other PIC related web/ftp/telnet sites: **http://www.man.ac.uk/~mbhstd/piclinks.html**. For details of the latest range of PIC devices, support hardware and literature, see the new Maplin Catalogue. PIC assembler software useful source code libraries and application notes can be down-loaded from the Micro Chip BBS, call the Maplin Technical Sales Helpline for details of how to connect to this BBS.



PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1	4k7	1	(M4K7)
R2,4	18k	2	(M18K)
R3,5-8,10	10k	6	(M10K)
R9,11	2k2	2	(M2K2)

CAPACITORS

C1	220µF 25V Radial Electrolytic	1	(AT49D)
C2	100nF 50V Ceramic Disc	1	(BX03D)
C3,5,7,9	100nF 16V Ceramic Disc	4	(YR75S)
C4,6,8	10µF 63V Radial Electrolytic	3	(AT77J)

SEMICONDUCTORS

D1,2	1N4001	2	(QL73Q)
LD1,2	Low Current 3mm Red LED	2	(CJ55K)
TR1,2	BC548	2	(QB73Q)
RG1	LM78L12ACZ	1	(WQ77J)
RG2	LM78L05ACZ	1	(QL26D)
IC1	SN74LS05N	1	(YF05F)
IC2	HCF4066BEY	1	(QX23A)
IC3	PIC16C84 *See Text*		

MISCELLANEOUS

SK1	2·5mm PCB-mounting DC Power Socket	1	(FK06G)
SK2	Right-angled PCB-mounting D-Range 25-way Socket	1	(FG27E)
	14-pin DIL Socket	2	(BL18U)
	18-pin Turned Pin Socket	1	(FJ66W)
	ABS Box Type H2853	1	(BZ73Q)
	M3 10mm Pozi-drive Screw	1 Pkt	(LR57M)
	M3 Steel Nut	1 Pkt	(JD61R)
	M3 Shakeproof Washer	1 Pkt	(BF44X)
	M3 Steel Washer	1 Pkt	(JD76H)
	Stick-on Feet Large	1 Pkt	(FW38R)
	Software Disk	1	(95211)
	PCB	1	(95129)
	Label	1	(95130)
	Instruction Leaflet	1	(XZ25C)
	Constructors' Guide	1	(XH79L)

OPTIONALS

32-pin Turned Pin Socket	1	(KW69A)
Universal ZIF Test Socket	1	(JK75S)
D25P/D25P Lead	1	(JC12N)
AC Adaptor Unregulated 300mA	1	(XX09K)
IC Lead Straightening Tool	1	(KU42V)
IC Extraction Tool	1	(FD54J)
IC Insertion Tool	1	(FR25C)
ESD Wrist Strap	1	(FE29G)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding optional) are available as a kit, which offers a saving over buying the parts separately.

Order As 95128 (PIC 16C84 Programmer) Price £19.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue.

PIC 16C84 Programmer **Order As 95129 Price £7.49**

PIC 16C84 Programmer Label **Order As 95130 Price £2.49**

PIC 16C84 Programmer Software Disk **Order As 95211 Price £2.99**

Positively Negative
THE IDENTITY OF THE ELECTRON

by Greg Grant

It began with a very basic problem; the nature of electricity. In 1733, the French physicist Charles-François du Fay discovered that two pieces of cork, electrically charged by the same means, repelled one another. If, however, one piece was charged by an electrified glass rod, it attracted a similar piece charged by a resin rod. From these experiments, du Fay concluded there were two distinct types of electrical fluid, one which he termed resinous electricity and the other vitreous electricity, from the Latin word for glass.

Fourteen years later, that great American all-rounder, Benjamin Franklin, rejected this hypothesis. As he saw it, there was simply one fluid or electrical substance which could exist in one or two conditions, namely an excess or a deficiency. Excess repelled excess and deficiency rejected deficiency because they had nothing concrete to offer one another. Excess, however, would attract deficiency and so the electrical fluid or substance flowed from excess to deficiency.

Not surprisingly, Franklin proposed that the excess be termed Positive Electricity, and the deficiency Negative Electricity, but did not determine which was resinous and which was vitreous.

Over the next century, or thereabouts, some of electricity's secrets were uncovered by minds of the quality of Volta and Oersted; Faraday and ampere; Ohm and Henry. Yet the phenomenon's fundamental nature remained elusive.

In 1846, however, matters began to move forward when the German Physicist, Wilhelm Weber and his collaborator, Karl Freidrich Gaus, applied the units based on mass, time and length that they had developed for magnetism, to electricity.

Electricity's nature, though, was still tantalisingly distant and so science began to consider the vacuum, and for a very simple reason. If an electric current could be forced through one, it could be observed in isolation, devoid of outside factors or influence.

The vacuum's original method of creation, already 200 years old, was still the easiest and most effective. What Evangelista Torricelli had done in 1643 was fill a 1·82m long glass tube with mercury, cork it and then upend it in a bath of mercury. When he removed the cork, the mercury dropped until there was a column of about 76cm still in the tube. Above that, of course, was a vacuum, in fact, the first ever artificially created one.Shortly, other physicists considered the possibility of producing a more effective scientific vacuum.

Two years after Torricelli, Otto von Guericke invented the first practical air pump and twelve years later, Robert Hook designed a faster acting, more effective pump, much used by the chemist Robert Boyle. Yet neither pump gave as good a vacuum as Torricelli's simple technique.

Clearly, what was needed was a pump capable of delivering a Torricellian vacuum. In 1855, the German inventor, Heinrich Geissler, taking advantage of Torricelli's discovery, produced just such a pump. It moved a column of mercury up and down, making the vacuum above the column suck air out of a container. Using this device, Geissler succeeded in producing the first decent vacuum tubes, an example of which is shown in Figure 1.

Three years later, the university of Bonn's Professor of Physics, Julius Plucker and his research assistant, Johann Hittorf, showed, using a Geisslar Tube, that electrical rays bend under the influence of a magnet. This suggested that such rays were, in some way, connected with electric charge.

This discovery, it may be said, began the scientific investigation not only of the nature of electricity but of the atom also.

By 1869, Hittorf, now a university lecturer, discovered that an object placed in front of a point-source cathode cast a shadow on the glow discharge. He concluded that whatever was leaving the cathode was doing so in a straight line.

Two years later, the British electrical engineer, C. F. Varley, developer of the Varley Loop Test for cable fault location, demonstrated that the rays in a Geissler tube could also be deflected by an electric field. He put forward the view that such rays must be metal particles 'pulled' from the negative pole by electricity.

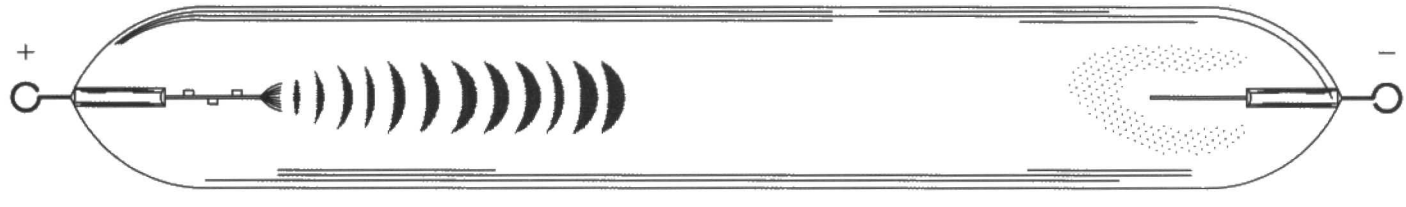


Figure 1. An example of a Geissler Tube from the early 1890s.

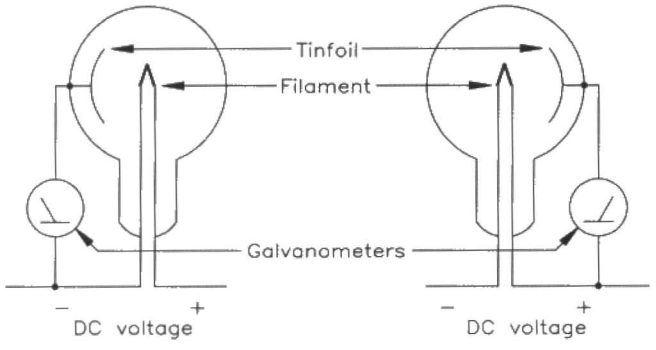


Figure 2. Edison's simple arrangement that revealed the nature of electrons. Subsequently known as the 'Edison Effect.'

In 1875, Sir William Crookes developed what came to be known as the Crookes Tube, an improved version of Geissler's original, with which he began his extensive research into electrical rays.

In the following year, Eugen Goldstein, studying at the University of Breslau, demonstrated that electrical rays were emitted from the whole cathode, not a particular point or points on it. Such rays could also, he found, cast sharp shadows.

Goldstein was the first physicist to use the expression Cathode Ray, doing so because he believed the fluorescence in the tube to be a radiation stream flowing from the cathode.

The word comes from the Greek 'Kata', meaning down and 'Hodos' meaning route, it having been evolved earlier by Faraday and Whewell to describe one of the components of a secondary cell. Goldstein's work led to the manufacture of concave cathodes so as to produce focused rays.

In 1878, Crookes reported on his research into cathode rays specifically and the vacuum discharges generally. He suggested that the rays "were due to the few gas molecules still remaining in the tube becoming electrified and then being repelled from the cathode."

In a lecture to the British Association for the Advancement of Science in the following year, Crookes spoke of cathode rays "casting shadows.. warming obstacles and (being) deflected by a magnet."

Crookes had also shown that the magnet made the rays curve in such a way as to suggest they were negatively charged. In short, Crookes concluded, such 'rays' were a stream of negative particles. This would prove to be prescient to say the least.

His report and subsequent lectures brought him a great deal of public attention, far more indeed than that accorded to Johann Hittorf for his no-less-extensive and equally fruitful researches.

By 1881, the great Herman von Helmholtz had entered the debate, with the opinion that electricity was composed of discrete particles which behaved like atoms of electricity. In the following year, science came tantalisingly close to a fundamental breakthrough in understanding, not to mention electrical technology.

The American inventor, Thomas Edison, was investigating the failure of his version of the incandescent lamp, whose filaments kept burning out and blackening the inside of the bulbs. In the course of this work, Edison decided to try a little experiment.

He covered the inside of a new bulb with tinfoil and connected it to the negative terminal of the filament battery via a galvanometer. When he switched on, nothing happened. On his connecting the tinfoil to the positive terminal however, the galvanometer registered a small current, as shown in Figure 2.

Edison, of course, kept voluminous notes, and so the above investigation was recorded, the result becoming known as the Edison Effect, and two years later, he applied for a patent on an electrical indicator based on his observations. This was surely the classic missed opportunity by the greatest inventor of the day or indeed, any day. It also illustrates the very considerable part the quest for decent lighting played in the development of what would later come to be called 'electronics'.

That a good vacuum was still difficult to achieve however, was demonstrated in 1883, when Heinrich Hertz, using a tube which was obviously defective, found that cathode rays were not deflected by a charged metal plate. He concluded, incorrectly, that the rays could not be charged particles.
Seven years later, Arthur Schuster calculated the rate of charge to mass of the particles making up cathode rays by measuring their magnetic deflection.

In 1891, the Irish physicist, George Johnstone Stoney, gave the name 'Electron' to what many of his scientific colleagues kept hoping would prove to be the fundamental unit of electricity.

Shortly after Stoney's intervention, Hertz appeared to get it wrong again when he showed that cathode rays could penetrate thin metal foil, and concluded that this supported the wave hypothesis as an explanation of the phenomenon. In fact, he was not so much wrong as ahead of his time. Another 30 years or more would pass before science would accept the wave-particle duality.

By 1894, the British physicist, J. J. Thomson, had established that the velocity of cathode rays was considerably lower than the speed of light, and in Germany, the physicist Philipp Lenard was expanding the possibilities of the Geissler Tube.

He manufactured discharge tubes with thin aluminium windows, which enabled the cathode rays to pass out of the tube and "be detected by the light they produced on a screen of phosphorescent material."

Lenard also demonstrated that cathode ray absorption "was roughly proportional to density, and that the rays became more penetrating with increased voltage."

In the following year, the French physical chemist, Jean-Baptiste Perrin, working towards his doctorate, decided to investigate cathode rays. His method was to direct a beam of rays across the diameter of an evacuated flask, as illustrated in Figure 3. He then attached a small cylindrical metal cup on the far wall of the flask, offset to one side of the beam's axis. Using a magnet, '.. Perrin diverted the beam into the cylinder. (It) acquired a substantial negative charge.'

Both the charge and direction of the magnetic field proved what Crookes had already surmised, cathode rays were indeed negative particles, not wave radiation.

Perrin also worked out the charge-to-mass ratio of these particles by the simple expedient of measuring the negative charge required to stop them illuminating a fluorescent screen. The identity of electricity's fundamental unit had been determined, at last. ELECTRONICS

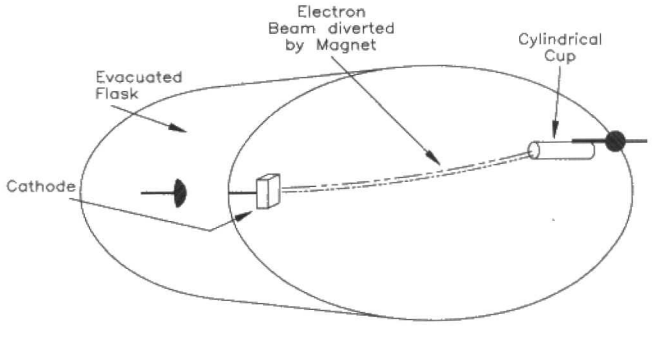


Figure 3. Jean-Baptiste Perrin's experimental apparatus for determining the nature of cathode rays.

Further Reading

The Cambridge Illustrated History of the World's Science. CUP/Newnes Books. Cambridge, 1983.
Electronic Inventions 1745-1976. GWA Dummer. Pergamon Press, Oxford, 1977.
Serendipidy: Accidental Discoveries in Science. John Wiley & Sons Inc., New York. 1989.
Pioneers of Science. Robert L. Weber. Adam Hilger, Bristol. 1980.
Ibid (4).Captions.

The Birth of the ANTENNA

by Greg Grant

Last year, 1995, marked the centenary of the antenna, a device so universal and indeed, crucial to our world, as to need almost no introduction. Yet, it was neither discovered nor developed, but arrived at accidentally by three men. One was a research physicist; one a lecturer at a naval college and the third, a young amateur experimenter with a wealthy father and indulgent mother. The physicist would be celebrated in a practical, if esoteric, way; the lecturer hardly at all and the experimenter positively showered with awards and distinctions. Indeed, even his death would engender a unique tribute.

In 1387, Heinrich Hertz, Professor of Physics at Karlsruhe, took the advice of his mentor, Hermann, Baron von Helmholtz, and set out to win the prize offered by the Berlin Academy for the first experiment that would demonstrate the existence of the electromagnetic waves predicted by James Clerk Maxwell.

Maxwell had put forward his theories as early as 1865, in a now-classic paper called 'A Dynamical Theory of the Electromagnetic Field'. It took some years for the theory and its associated equations to be accepted, and the first breakthrough came with Hertz's generation of electromagnetic waves, which he announced in the journal 'Annalen Der Physik' in 1888.

The equipment Hertz used is shown in Figure 1. His antenna was the first true resonator and was based on a disembowled Leyden Jar, that earliest of all electronic components aside that is, from pieces of fur and amber. The inner and outer foils of this early capacitor became the two arms of a dipole, separated by the Spark Gap. Obviously, this arrangement had both inductance and capacitance and so was a resonant circuit, which meant that if it was energised sufficiently to enable sparks to cross the gap, it would radiate at a collection of frequencies determined by the capacitance and inductance. The energising mechanism was a Ruhmkorff Coil, called after its creator, the German physicist, Daniel Ruhmkorff.

It was effectively a step-up transformer incorporating a magnetic interrupter, which produced spark discharges. Hertz's system, therefore, constituted the earliest form of radio transmitter, the Spark Gap.

For reception, Hertz used Knochenhaur Coils, flat loops of metal strip, the turns insulated by sealing wax and with a spark gap on each coil, as shown in Figure 2. This receiving loop had a radius of 35cm, which was found by experiment to be the proper size to be in resonance with the oscillator.

It was with these arrangements that Hertz established that electromagnetic waves existed and could also be bent and reflected. Hertz also, of course, modified this equipment a number of times in the course of his experiments and the frequencies at which he operated have been estimated to be anywhere between 50 and 500MHz, the present-day Very High Frequency (VHF) and Ultra High Frequency (UHF) bands. Shortly, however, what had come to be known as Hertz resonators were '. . . superseded by Coherers of various patterns'.

The coherer (a number of which are illustrated in Figures 3a to 3d) was basically a switch whose normal condition was off. when a voltage above a certain threshold level was applied, however, it activated, staying in this condition until tapped, or nudged physically.

The principle behind it had been stumbled across in 1879 by the Anglo-American physicist, David Hughes. He had noticed that when a Ruhmkorff Coil was operated close to a microphone-telephone circuit, the microphone resistance changed and sounds were heard in the telephone earpiece. Hughes took the view that the coil's electromagnetic discharge was inducing a reaction in the microphone's carbon powder, but friends persuaded him he was mistaken. Consequently, the coherer was later re-invented, as it were, by Eduoard Branly, professor of physics at the Catholic University of Paris. He published his findings in French in 1890, and they first appeared in English in the following year in the journal 'Electrician'.

The Branly design set the standard for almost all subsequent coherers. It was a glass tube containing loosely packed iron filings with connectors at either end. Not the least of the ironies concerning this would-be antenna, was that its inventor had no real idea as to why his device functioned as it did!

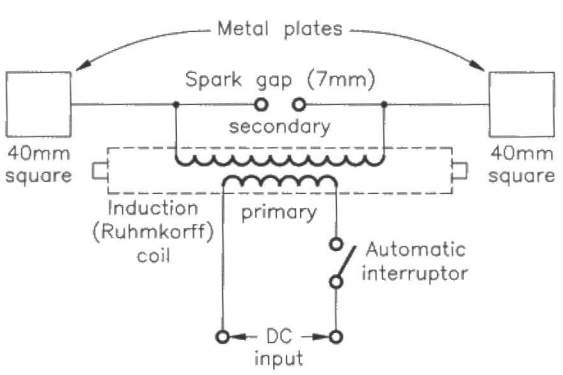


Figure 1. Heinrich Hertz's original equipment of 1887.

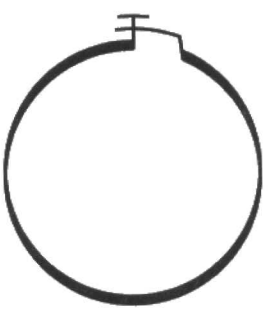


Figure 2. Hertz's receiving antenna – a Knochenhaur Coil.

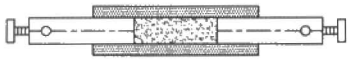


Figure 3a. Branly's original coherer, 1890.

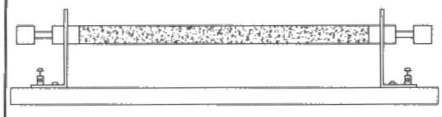


Figure 3b. Lodge's coherer of 1894.

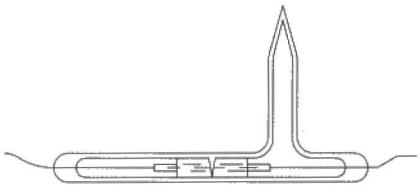


Figure 3c. Marconi's coherer of 1895.

Figure 3d. Popov's coherer of 1895.

Branly, however, was not alone in discovering some of the odd properties of metal filings. In Britain, Oliver Lodge also invented a similar device. In fact, he was the first scientist or engineer to term this switch a coherer, thus indicating that he at least understood how it functioned. Lodge has a unique place in the development of communications engineering, not least, for his belief that the selective response of one individual receiver to an equally individual transmitter – what we, today, would term simplex operation – was crucial to ANY progress towards a communicative system, and particularly one based on what was still referred to as Hertzian waves.

A prolific inventor and component developer, two of Lodge's patents had important implications '. . . in particular, for the design of antennas and for the techniques of coupling electrical oscillations into and out of the antenna'. In fact, by 1892, thanks in large measure to Lodge, all the elements of an electromagnetic communications system were to hand, including the unearthed dipole and the Branly-Lodge coherer. In 1894, he gave a lecture entitled 'The Work of Hertz', which was read and admired by a Russian physicist and naval college lecturer called Alexander Popov.

In it, Lodge had outlined his experiments with a coherer. Popov repeated this experiment and, early in 1895, began investigating both the coherer and metallic powders. His receiver is shown in Figure 4. The coherer has a rubber ring around it for protection from the bell hammer. It is connected to a 4·5V battery whose current I flows through the coherer and the winding of relay RI, although it is not powerful enough to activate the armature (a).

When an electromagnetic wave strikes the coherer, however, the resistance of the powder within drops, current increases and (a) closes. This completes the circuit at z and activates the bell. When the tube is tapped, its resistance increases and the relay opens the bell circuit.

In the course of his experiments, Popov discovered that if he connected a 2·5m long wire to either points X or Y, the receiver picked up signals from a Hertzian vibrator, whose spark gap was lying in oil. He also noticed that when one side of the coherer was connected to a lightning rod and the other to earth, his receiver picked up atmospheric disturbances even when they occurred at a considerable distance. This led him to believe that his equipment could be used for over-the-horizon signalling. Popov, of course, was not alone in experimenting with Hertzian waves.

At the same time, a young Italian-Irish experimenter was also endeavouring to extend the infant technology. His abiding pre-occupation was distance. In fact, it would not be at all inaccurate to say he was obsessed with it. Guglielmo Marconi was conducting his experiments in the garden of the family home, the villa Grifone, and they were far from successful. Indeed, he had '. . . already tried to make his antenna radiate more powerfully by attaching metal plates to the arms. He had also tried raising it higher above the ground'.

This, of course, brought him a further problem; the inconvenience of having both the spark gap and the coherer out of reach for adjustment.

In early 1895, however '. . . while using slabs of sheet iron to increase the transmitter spark's wavelength, he placed one on the ground and held the other in the air. This, in effect the first aerial, produced a large increase in the signal strength and in the range – from about 100 metres to 1 kilometre'. The equipment he used is shown in Figure 5.

He had also adopted a similar arrangement at the receiver, which meant that both the transmitter spark gap and the receiver coherer were now at ground level and therefore, easily adjustable.

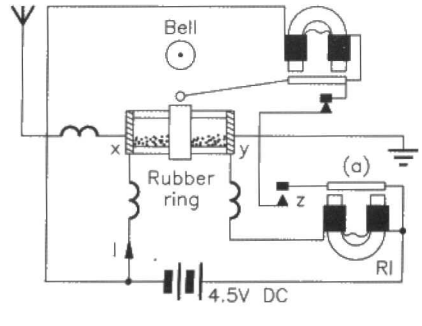


Figure 4. Alexander Popov's receiver.

What Marconi had done, of course, was use the Earth as one of the dipole arms. It was this arrangement which, at last, gave him the distance he craved. In fact, it would be fair to say that this was the antenna Marconi used for the rest of his life, in one form or another.

He used it in his trials between Dover and Wimereau in 1898, and again in Newfoundland in 1901. He was not the first to employ this type of antenna, but his use of it for transmission WAS an innovation. So, how did it work? The truth is that Marconi not only had no idea how it functioned, he was none too concerned about his ignorance either, for it gave him what he wanted: distance. And this could be said of all of his antennas up to the outbreak of World War One.

Indeed, where Marconi was concerned, 'the original acts of creative insight were seldom his. Where he excelled was in the indispensable process of critical revision'. Time would prove the above judgement prescient.

When the 'syntonic' systems patented by Lodge in Britain and Braun in Germany failed to radiate sufficient energy, Marconi solved the impasse with '. . . two simple yet ingenious innovations'. He used an inductor to couple the antenna to the transmitter, in fact, two inductors placed closely together instead of the single coil used in many of the transmitters of the day. Furthermore, he made the inductances variable, along with the transmitter circuit capacitor. In short, he tuned his antenna and transmitter output circuit into resonance with each other. Consequently, a great deal of energy was now radiated into space and at one frequency only.

Five years after his discovery of the antenna, Marconi, despite scientific opinion, was achieving ranges of 60 to 100 miles. No more would ships be out of sight once over the horizon, nor proconsuls be able to ignore an imperial edict. The world of C^4 (Command and Control through Communications) was but a development or two away.

Hertz did not live to as much as glimpse the brave new world he had done so much to bring about. He died on New Year's day 1894, of blood poisoning, at the early age of 36.

In our own time, the SI unit of frequency measurement was renamed the Hertz in his honour.

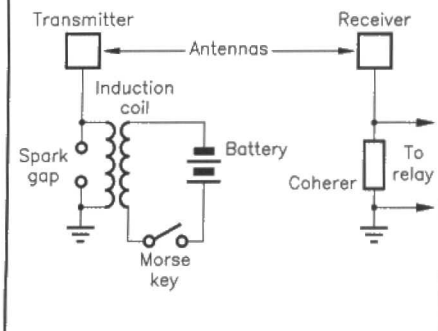


Figure 5. Marconi's experimental equipment, 1895.

Popov survived his antenna experiments by a decade, living long enough to note Marconi's successful experiments between Dover and Wimereau and his bridging of the Atlantic by radio. He died of a brain haemorrhage on the last day of December, 1905. His health had been affected by the harassment of the authorities, who were opposed to the democracy movement which Popov espoused, particularly for his students. He was 46.

Marconi, laden with renown, died in Rome on July 20th 1937, after the latest of several heart attacks. Thousands of mourners attended the state funeral and the Italian Radio System observed a 5-minute silence.

In Britain and its dominions across the world, the Post Office and the British Broadcasting Corporation (BBC) observed a two-minute silence. On that day, the world was, however briefly, reminded of the contemplative quiet it had known before the birth of the antenna.

References

Electronic Inventions 1745 - 1976. G.W.A. Dummer. Pergamon Press, Oxford. 1977. Page 50.

Science For The Citizen. Lancelot Hoghin. George Allen & Unwin Ltd., London. 1938. Page 755.

Syntony & Spark. H.G.J. Aitken. Wiley-Interscience, London. 1976. Page 132.

Ibid (3). Page 192.

Electronics World + Wireless World. Article 'Marconi Beginnings', January 1992. Page 74.

Ibid (3). Page 187.

From Spark To Satellite. Stanley Leinwoll. Charles Scribner's Sons, New York. 1979. Page 10.

ELECTRONICS

TECHNOLOGY WATCH

by Keith Brindley

The BBC has warned that digital television services in the UK will be developed incoherently unless some form of standardisation is agreed upon. John Birt, the BBC's director general, replied to the government's consultation paper on digital television with proposals that the telecommunications watchdog body, Oftel, should perhaps be the regulatory source to maintain standardisation between the various broadcasters.

Without such standardisation between terrestrial broadcasters such as the BBC and the independent broadcasters, satellite services such as British Sky Broadcasting's proposed digital television system, and any others which come along, then users will be faced with yet another variety of set-top boxes to decode the digital signals.

On the face of it, this seems a good stance. After all, if terrestrial and satellite services were to start up without standardisation, then there is a good chance that they will choose different systems, or at least, different variations of systems. That would be only natural, as they each have their own interests at heart.

Doubtless, enterprising decoder manufacturers will be able to combine any number of different methods of encoding into a single set-top decoder box (much as they have already done with the many variations of satellite television encoding systems currently used). However, costs would be at a minimum if the broadcasters got their act together at this early stage and agreed on a common system for the whole of the UK. Better still, what about a common system for the whole of Europe?

The BBC's argument breaks down, of course, in that under no common circumstances is the mixed bag of broadcasters likely to agree a single standard – they've never done it in the past, have they? And without agreement, the only course of action is to impose a standard. Problem is, the only way to impose a standard is to do it governmentally – an unlikely scenario, given recent political history.

All this is a pity, because digital television services are planned to be starting sometime next year from satellite by BSkyB, and sometime the year after by the BBC. Putting it metaphorically, this really is the last ditch where standards could be created. Once any broadcaster jumps the ditch, only the consumer gets to pay the cost.

PCTVs

The drive by computer manufacturers to combine the functions of television display inside a computer might be about to take a new turn. You'll have seen the Fujitsu PCTV in the shops, no doubt. It's a personal computer-cum-television, in one box, intended for the home market. Being a cross between the two functions, it was a bit of a problem tax-wise. Trouble is, until a recent ruling, it wasn't known whether the thing was a computer with television bits inside (which is what Fujitsu say it is), or a television with computer bits inside (which is what HM Customs & Excise say it is).

The difference between the two is critical, because import duty on computers is at a rate of 4·4%. Import duty for televisions is, on the other hand, 14%. By classifying the device as a television, therefore, almost 10% extra can be levied.

At a recent tribunal, Fujitsu argued that the PCTV is a composite machine, so should be classified on its main role as a computer. Customs & Excise won the ruling, however, arguing that the PCTV's main role could not be clearly identified, therefore, it is within its right to impose the television import duty.

All it means, of course, is that it won't be financially viable for computer manufacturers to produce PCTVs, because a cost margin of 10% will make a PCTV commercially unsuccessful. Nice one, Customs & Excise.

Losing our Memory

The price of computer memory is at an all-time low. It's happened dramatically over the last few months too. A year ago, you could pick up a 16M-byte single in-line memory module (SIMM) for the (then) cheap price of £350. The same SIMM at the time of writing can be located for £95 – just over a quarter of its price twelve months prior. Everyone, it should seem, is happy. Users are happy. The modern computer with its expanding operating system and gargantuan applications, needs mountains of memory to cope with its everyday life at anything other than the speed approaching that of a drunken snail. Computer manufacturers are happy. When you're selling a computer at a price which must interest users, and your base parts cost too high a percentage of the total, then any reduction in part price can only mean good news. On the face of it, too, the memory manufacturers should be happy. Cheaper product prices mean greater sales, which in turn, means greater turnover, which in turn if handled properly, should mean greater profits.

Yet, actually, the memory manufacturers themselves aren't happy. It appears that there has been a price war between manufacturers which, while not only causing stimulation of the market, has meant that manufacturers have been forced to decrease their profit margins. Profit margins on memory a year ago, for example, were over 60%. Now, they tell us, margins are down to near zero. To counter this, the apparent glut of SIMMS will have to be stemmed.

As a result, there is a growing trend in manufacturers to slow production. Companies like Fujitsu, Hitachi, Hyundai, LG Semicon, Mitsubishi, NEC, Samsung, TI-Acer and Toshiba are scaling back the manufacture of memory. Reports of other slowdowns are regular occurrences. This is all with the intent of artificially manipulating the market to put the stop on any further fall in memory prices.

The problem with such a technique is that the cause can drastically underestimate the effect. That, after all, is what happened in the first place. Retailers of memory, it could be argued, created the current problem themselves, by forcing prices down to be ever more competitive. Manufacturers had to lower their profit margins to be able to supply at the prices the retailers wanted in order to keep the retailers' customers happy. While the bandwagon was rolling, everyone was happy.

But now the bandwagon is grinding to a halt. Once there is anything suggesting a memory shortage, the market will jump to the obvious conclusion and prices will once again rise. Given the nature of the market, prices can be expected to rise beyond what they should, too.

All this means then, that if you fancy some more memory in your computer, get it now! It can't get any cheaper, and will probably only get rapidly more expensive. This time next year, I'll probably be reporting on the highest memory prices in computing history. I'm joking, of course. At least I hope I am.

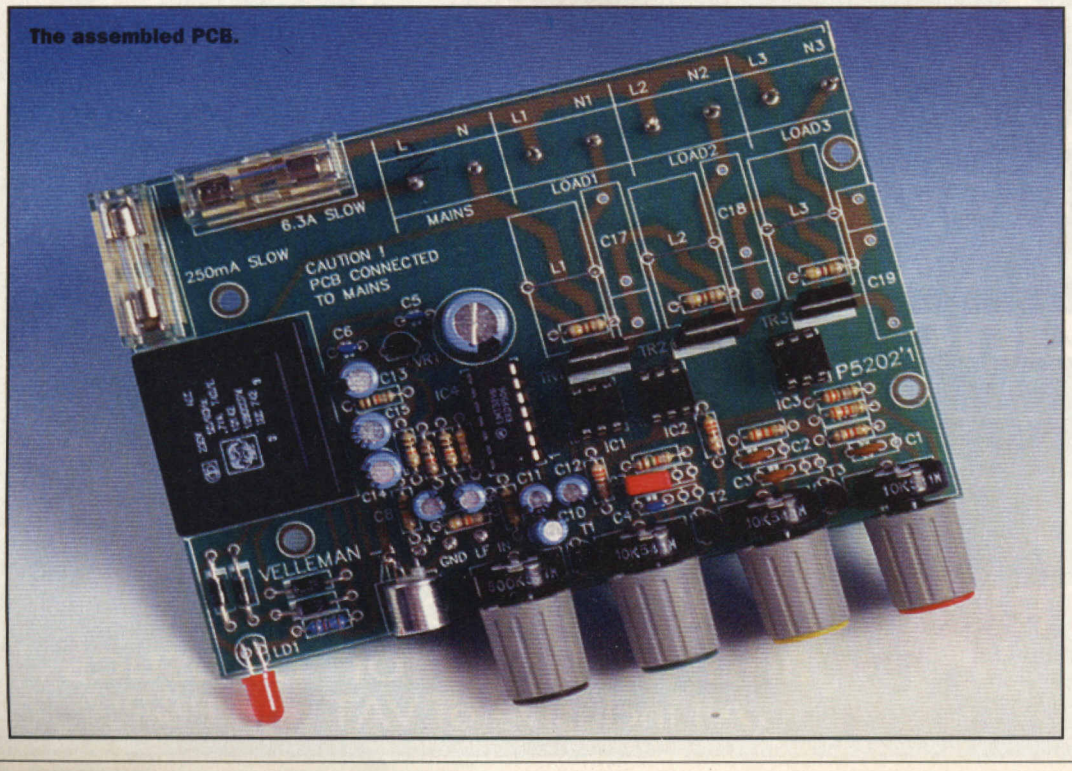
The opinions expressed by the author are not necessarily those of the publisher or the editor.

PROJECT

3-Channel SOUND-TO-LIGHT UNIT

Review by Maurice Hunt

Add some sparkle to your next party or disco by using this 3-channel Sound-to-Light unit to create dazzling lighting effects that change in time to the rhythm of the background music! The unit features adjustable sensitivity on its 3 channels, that react to the bass, mid-range and treble elements of the music, plus an overall sensitivity (volume) adjustment, so that the lighting effect can be tailored to match any sound level or music type.



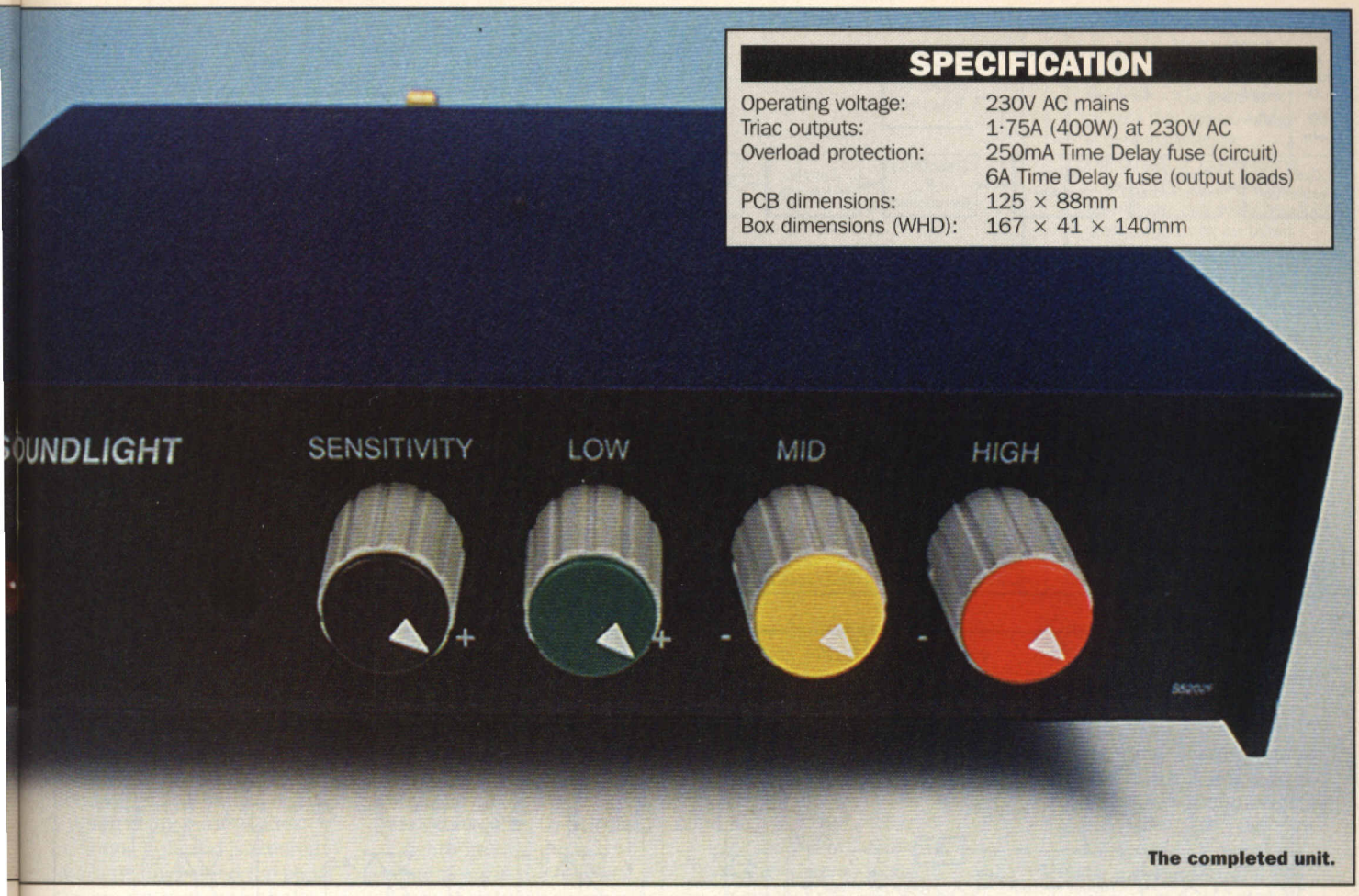
The assembled PCB.

This compact and easy to operate Sound-to-Light unit has three opto-isolated triac-driven outputs, capable of directly driving mains powered lamps of up to 400W per channel. There is a built-in microphone to pick up the background sound, or the unit can be fed an audio input directly, by means of a line-level input. A front panel LED confirms that the unit is powered up.

The project contains almost all the parts needed to produce a working unit, including a high quality PCB and pre-drilled ABS casing, complete with front panel label and knobs with different coloured caps, to create an attractive and professional finished appearance. However, a twin-core mains cable with plug are required to supply power to the unit and mains cable of a suitable current rating will be needed to connect the output sockets to the PCB. Additionally, if interference suppression is required (and this is to be recommended, to avoid the triac switching being heard on nearby AM radio receivers), a toroidal choke and capacitor will be required for each channel (not supplied in kit). Please note that the output sockets supplied are of the American (shaver type) two-pin specification, without earth.

SPECIFICATION

Operating voltage:	230V AC mains
Triac outputs:	1·75A (400W) at 230V AC
Overload protection:	250mA Time Delay fuse (circuit) 6A Time Delay fuse (output loads)
PCB dimensions:	125 × 88mm
Box dimensions (WHD):	167 × 41 × 140mm



The completed unit.

However, the casing can be modified to accept the more usual European-standard sockets, which are essential for 230V operation.

Circuit Description

Refer to the block and circuit diagrams shown in Figures 1 and 2, respectively. The AC mains voltage is fed through fuse F2 into the step-down transformer, TRANSFO. This brings the voltage down to 9V AC. From here, it passes into the bridge rectifier formed from diodes D1-4, to produce a DC supply. This is smoothed by the large value capacitor C16, and fed into voltage regulator, VR1, to give a steady 8V DC supply to the remainder of the circuit. Low-frequency decoupling of the supply is achieved by C13, while C5 & C6 provide high-frequency decoupling.

Electret microphone insert, MIC, (if fitted) converts the background sound level into a small variable electrical signal, which is boosted by the preamplifier stage, IC4d. Alternatively, if the microphone is omitted, the audio signal can be fed directly into the line level input, in which case, the preamplifier stage is bypassed; the microphone terminals are short-circuited in this case, to prevent spurious signals from being picked up by the preamplifier.

The boosted audio signal passes onto the main amplifier stage, IC4a, whose level of gain is determined by adjusting RV4 – this sets the overall sensitivity of the unit. Note that IC4b & IC4c are unused parts of the LM324 operational amplifier chip; their inputs and outputs are tied to either the positive or negative DC supply rails to prevent spurious interference with the other two op-amp sections.

The output of the main amplifier is fed via coupling capacitor C12 into each of the three filter networks, formed by R11, C7, C4 & RV1 (bass filter), R12, C2, C3 & RV2 (mid-range filter), and R14, C1 & RV3 (treble filter) that precede the buffer amplifiers (T1-3) for each channel. The preset potentiometers RV1-3 enable the response of each of these three filters to be adjusted independently to suit a range of audio input spectra; for instance, you might prefer the unit to react more to the higher notes in the music than the lower ones, so you would increase the sensitivity of the treble channel while de-sensitising the bass channel. This enables a more even light pattern to be produced to suit differing types of music, rather than having, say, one light on more often than the other two.

The buffer amplifiers drive the LEDs that sit within the optoisolators, IC1-3. When their internal LED is lit (which, obviously, cannot be seen), the optoisolators (electrically isolated) outputs pass current to trigger the triacs TR1-3. The isolators are needed to keep the AC mains switched outputs completely separate from the low level DC that the circuit operates at for reasons of electrical safety and to avoid interference/feedback problems.

The triacs switch the mains output to the loads, these usually being mains-rated incandescent lamps. Fuse F1 protects the triacs from excessive current in the event of a short circuit or overload, allowing each channel to pass just over 2A (i.e. a little over 6A total) before blowing. Optional electrical interference suppression may be fitted in the form of toroidal chokes L1-3, and capacitors C17-19 – there is provision on the PCB to fit these optional components (not supplied in the kit). If, however, you do not wish to fit these components, wire links should be fitted in the L1-3 positions; the space for the capacitors C17-19 is left unused.

FEATURES

- Optically isolated triac driven outputs
- Bass, medium, treble and overall sensitivity adjustment
- Built in microphone
- Line level input
- Pre-drilled casing included
- Provision for optional interference suppression
- Power on LED

APPLICATIONS

- Discos
- Parties
- Entertainment events

PROJECT RATING 3

Kit Available
Order as 95212
Price £39.99A1

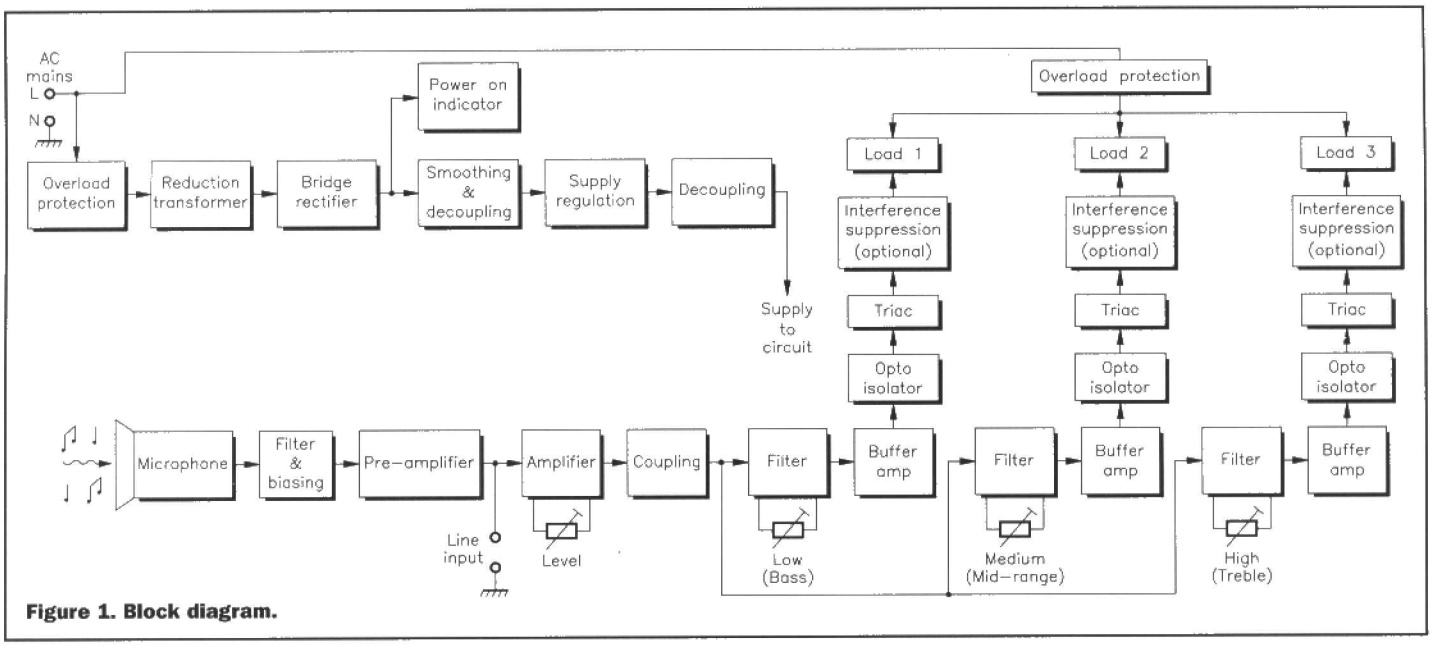


Figure 1. Block diagram.

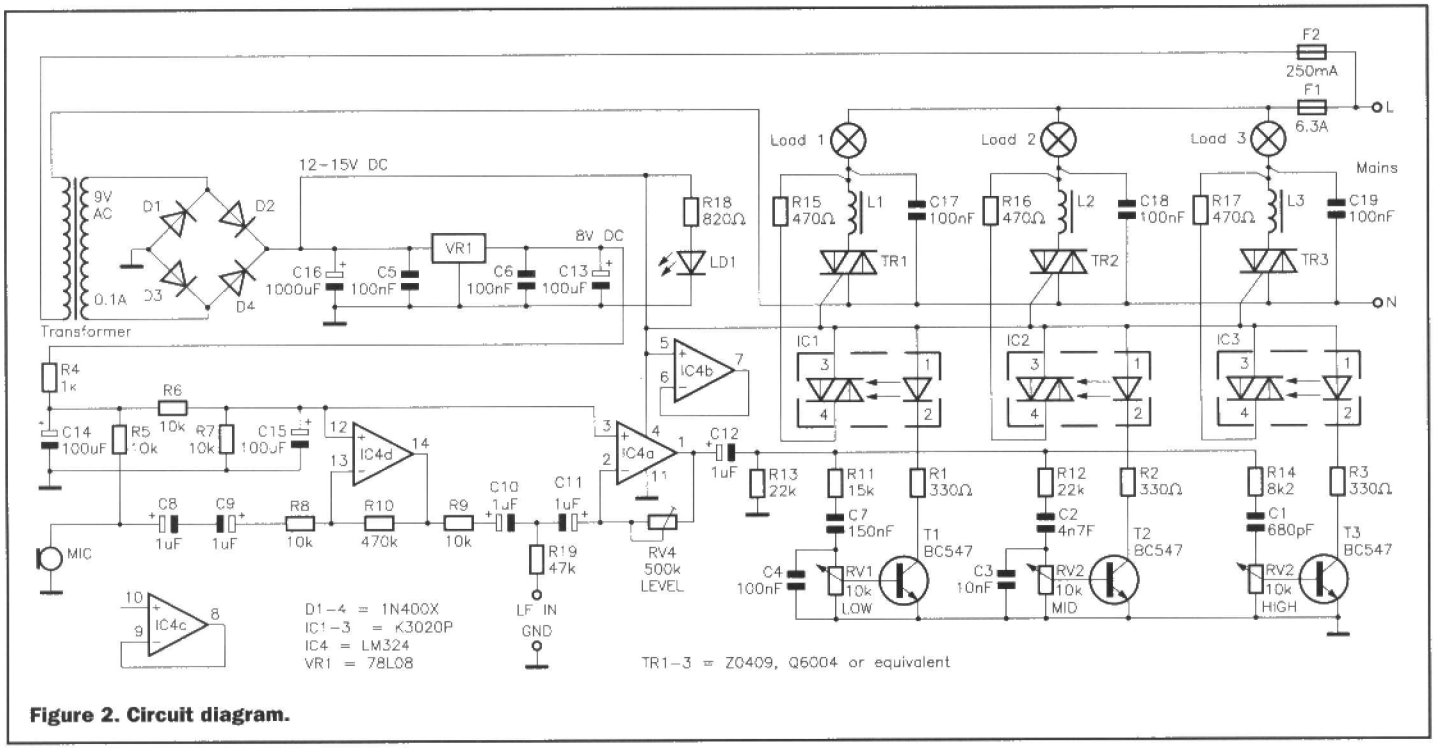


Figure 2. Circuit diagram.

PCB Construction

The kit contains a high quality single-sided fibreglass PCB with printed legend to assist with component placement. The board is constructed in the usual order of ascending component size/height. Commence by fitting the three wire links in the L1 to 3 positions if you are not fitting the (optional) interference suppression capacitors C17 to 19 and chokes L1 to 3. If fitting the suppression components, do not fit the wire links.

Take care to align the DIL holder notches with the legends, and also to correctly orientate the polarised components, i.e., diodes, LED, transistors, voltage regulator, electrolytic capacitors and triacs.

The 12 PCB pins are a tight fit in their holes – heating them with a soldering iron while applying moderate steady pressure will ease them in. If fitting the microphone insert, be sure to connect it to the PCB pins the correct way round; the '–' terminal is that which contacts the metal body of the microphone (there may be two –ve terminals on the microphone). Fit the microphone so that its face sits flush with the edge of the board, but with the body raised so that is sits slightly above the PCB – else it will tend to pick up vibrations through the base of the box. If the microphone is not being used, it must be removed and its connections to the PCB short-circuited. A length of screened cable (e.g. XR15R) should then be used to connect to the line input (GND and LF IN terminals).

Important

Apply a thick layer of solder along the length of the already tin-plated (thicker) PCB tracks, to increase their current handling capacity.

The ICs IC1 to 4 should be plugged into their sockets last of all. Having checked your work for misplaced components, solder whiskers, bridges and dry joints, clean excess flux off the board using a suitable solvent.

Final Assembly

The kit is supplied with a pre-prepared ABS plastic box. The first task is to wipe the front panel clean and apply the label. Next, fit the snap-in spindles into the four potentiometers, rotate the spindle to either end stop, then push the knobs onto the spindles while supporting each potentiometer in turn. Align the notch in the end of the knob with the end stop point of the potentiometer (i.e. at the 5 o'clock or 7 o'clock position, as appropriate). Tighten the knob's central fixing screw, then press a coloured end cap into place (using the colour scheme of your choice!)

The three output sockets supplied are of the American two-pin type, suitable only for

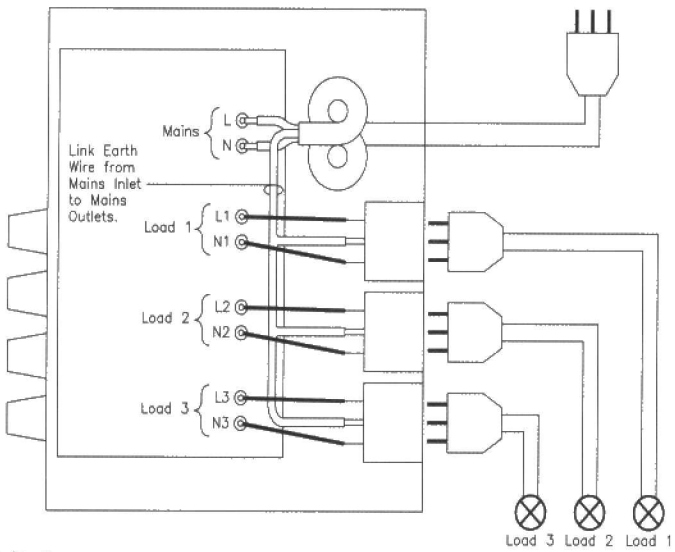


Figure 3. Wiring diagram.

Important Safety Note

It is important to note that mains voltage is potentially lethal. Full details of mains wiring connections are shown in this article, and every possible precaution must be taken to avoid the risk of electric shock during maintenance and use of the final unit, which should never be operated with the box lid removed. Safe construction of the unit is entirely dependent on the skill of the constructor, and adherence to the instructions given in this article. If you are in any doubt as to the correct way to proceed, consult a suitably qualified engineer.

use at 110V. As the unit is to be powered from 230V AC mains, these must be discarded and instead fit an alternate type, rated at 2A 250V AC minimum, such as the plastic 3-pin chassis socket, type SA2404 (Order Code HL48C). This will require a 19mm diameter round mounting hole and is secured by a large nut behind the panel. The pre-cut rectangular holes could be filed out to suit, with any excess being sealed with hard setting epoxy resin or similar. The completed board can now be fitted into the box, by passing the knobs and LED (and line input cable, if fitted) through the appropriate holes in the front panel, and securing the board in place using the four shakeproof washers and screws supplied.

The board should now be wired up to the outlet sockets and a mains cable as shown in the wiring diagram, Figure 3. Note the method of securing the mains cable, by twisting it tightly around the two spare posts in the box, in a figure-of-eight. Use a mains-rated cable capable of passing at least 3A (e.g. XR47B) for the wiring to the outlet connectors, and rated at a minimum of 6A (e.g. CW69A) for the mains lead. Attach a 13A plug to the mains lead, fitted with a 7A fuse (Order Code DK19V).

Finally, fit the cover onto the box with the four screws provided.

Testing and Use

Connect the unit's three outlets up to suitable loads, such as mains powered incandescent lamps of no higher than 400W each. Note that this unit will NOT drive halogen or fluorescent lamps. Plug the unit in to a mains outlet, and switch on. The front panel LED should be lit, and by altering the front panel controls, the load lamps should be switched on and off in response to an audio input, applied either to the built-in microphone (if fitted), or from a tape player output (or similar), via the line level input (if fitted).

By using different settings of the controls, it should be possible to adjust the lighting pattern to react to different volumes and elements (i.e. bass, mid-range and treble sections) of the audio input being played.

Note that no damage will result if the unit is operated with one or more of the loads disconnected.

Always operate the unit in accordance with the mains safety warning printed in this article. ELECTRONICS

PROJECT PARTS LIST

RESISTORS: All 0·6W 5% Metal Film (Unless Stated)

R1-3	330Ω	3
R4	1k	1
R5-9	10k	5
R10	470k	1
R11	15k	1
R12,13	22k	2
R14	8k2	1
R15-17	470Ω	3
R18	820Ω	1
R19	47k	1
RV1-3	10k Vertical Preset Potentiometer	3
RV4	470k/500k Vertical Preset Potentiometer	1

CAPACITORS

C1	680pF Ceramic Disc	1
C2	4n7F Ceramic Disc	1
C3	10nF Ceramic Disc	1
C4-6	100nF Resin-dipped Ceramic	3
C7	150nF Polyester	1
C8-12	1μF 50V Radial Electrolytic	5
C13-15	100μF 16V Radial Electrolytic	3
C16	1,000μF 25V Radial Electrolytic	1

SEMICONDUCTORS

D1-4	1N400X	4
T1-3	BC547	3
VR1	78L08	1
LD1	5mm Red LED	1
TR1-3	ZO409/Q6004	3
IC1-3	K3020P	3
IC4	LM324	1

MISCELLANEOUS

TRANSFO	9V 0·1A PCB-mounting Step-down Transformer	1
MIC	Electret Microphone Insert	1
F1	6·3A 20mm Time Delay Glass Fuse	1
F2	250mA 20mm Time Delay Glass Fuse	1
	20mm PCB-mounting Fuseholder with Cover	2
	6-pin DIL Holder	3
	14-pin DIL Holder	1
	2-pin Mains Socket	3
	PCB Pin	12
L1-3	Wire Links *See Text*	3
	PCB	1
	Box	1
	Knobs with Caps	4
	Self-Tapping Screws	8
	Shakeproof Washers	4
	Front Panel Label	1
	Instruction Leaflet	1
	Constructors' Guide	1

OPTIONAL (Not in Kit)

	50μH/6A Toroidal Choke	3
	100nF 250VAC 500VDC Polyester	3

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available in kit form only.

Order As 95212 (3-Channel Sound-to-Light Unit) Price £39.99A1

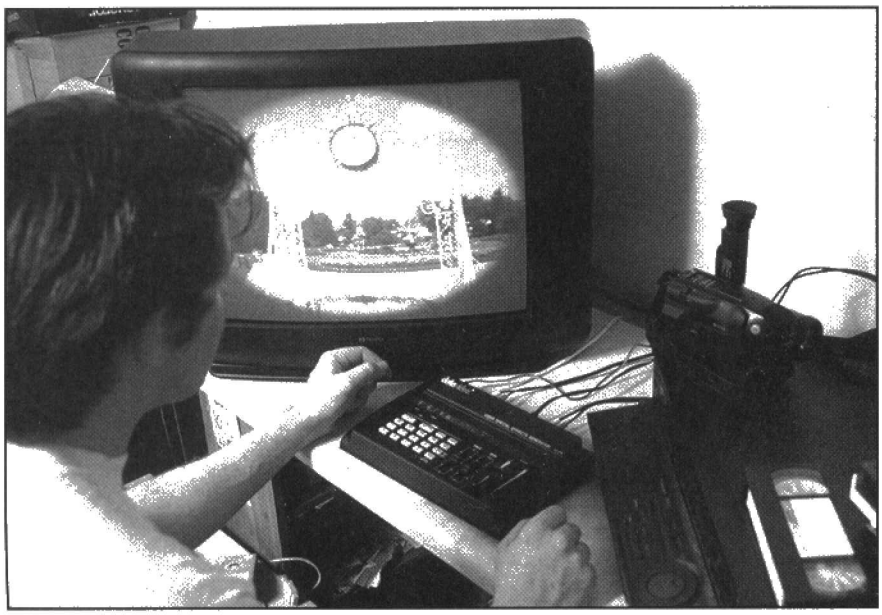
Please Note: Some parts, which are specific to this project (e.g., PCB), are not available separately.

REVIEW

Datavideo VP-275 VIDEO EFFECTS PROCESSOR

Reviewed by Martin Pipe BSc (Hons), AMISTC

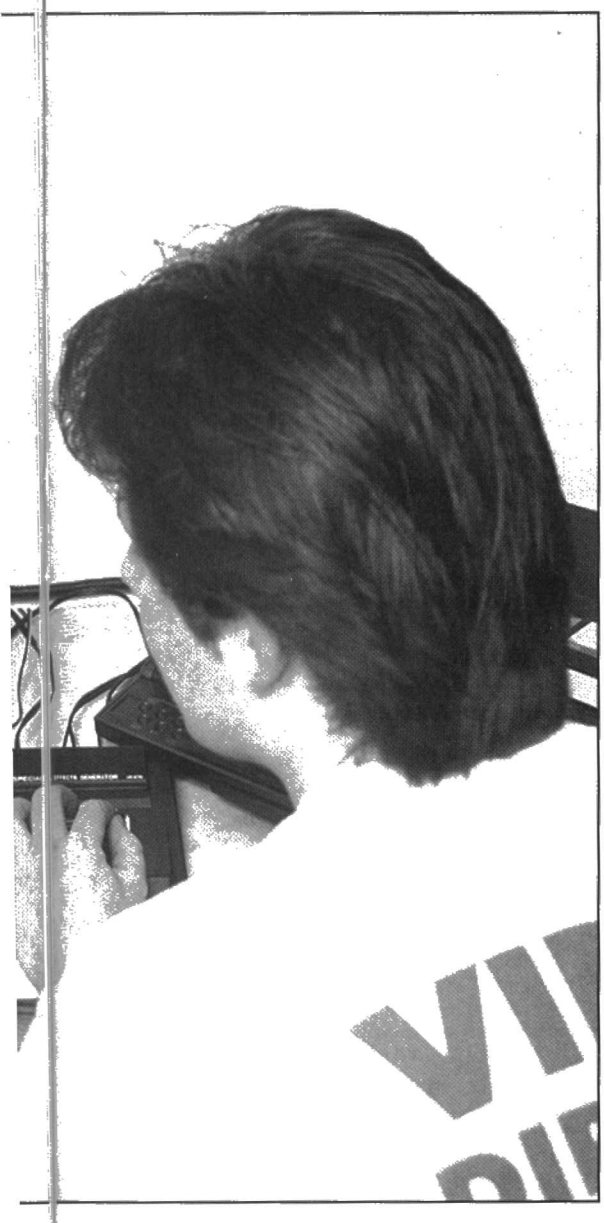
Camcorders are quite flexible little beasties, capable of a variety of creative possibilities that extend beyond simple 'point-and-shoot' recordings of baby's first steps or that holiday outing. Compact machines of decent quality (such as the highly regarded Canon range from Maplin) are now available at keen prices, introducing a broader range of people to the art of video film-making.



Essential Accessories – and Why You Need Them

Apart from a supply of blank tapes, the first accessories that any camcorder owner should consider are a tripod, spare battery and external microphone – all items available from Maplin. A tripod is essential for getting rid of jerkiness and shake from your pictures, particularly for long-distance shots (where the zoom lens is set to maximum) and pans (in which the frame moves slowly from left to right, or vice-versa). Decent tripods give you much better control of your 'video window', and potentially deliver results that are far more professional than the 'Smith and Jones home-videos' that most people seem to expect.

Spare batteries are also essential – especially if you do much recording to obtain a wealth of source material. It is also possible to leave one battery on charge while the other is slotted into your camcorder. Extended-life batteries are worth considering to improve shooting times.

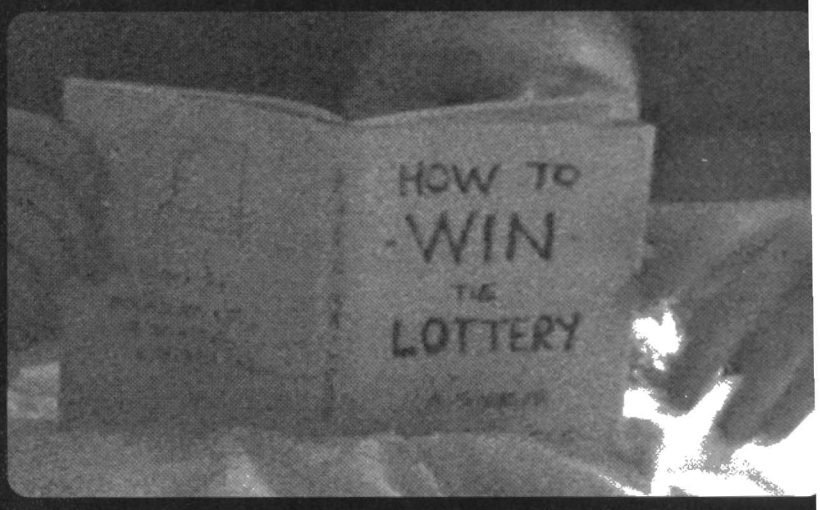


The microphones built into camcorders are a little on the naff side, and tend to pick up handling noise and the whirring of motors – as a camcorder ages and begins to wear out, those whirring noises tend to get a little more obtrusive. An external microphone is worth adding to your shopping list, should your camcorder give you the opportunity to connect one.

It's important to get to grips with the basics – primarily how to handle the camcorder, plan shooting and carry out basic edits (if you happen to be shopping for a VCR, we recommend a model with a jog/shuttle dial and – if possible – control over the camcorder's deck controls via an edit terminal).

We would recommend joining a local videomakers' club, where you will find a wealth of friendly advice. These clubs usually run tutorial sessions, and theme days out, where you can gather inspiration (and footage) for a project. The magazine Camcorder User is a good source of useful practical information, and features news (and often listings) of videomakers' clubs around the UK.

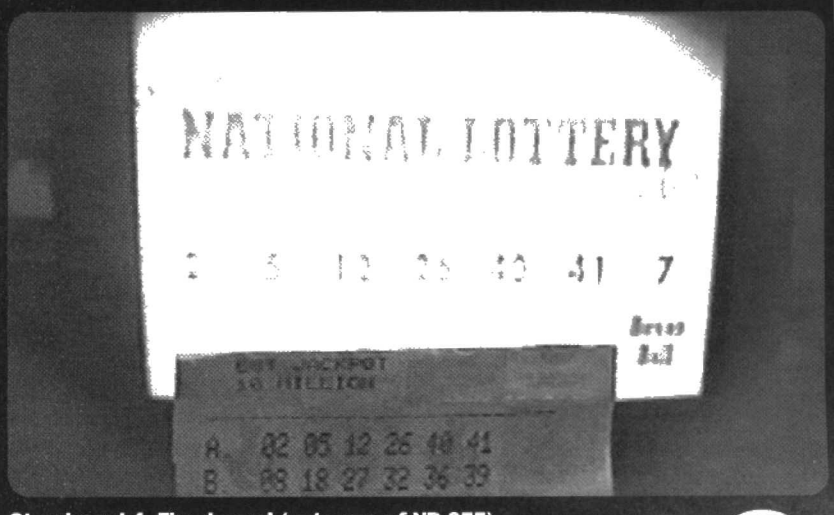
Once you're au fait with the essentials, you probably will be wondering how you can add some basic video effects (like you see on TV) into your productions. Used carefully, video effects can be used to make a point (such as the passing of time) clearer to your audience, enhance a mood that you are trying to impart, or simply grab your viewers' attention.



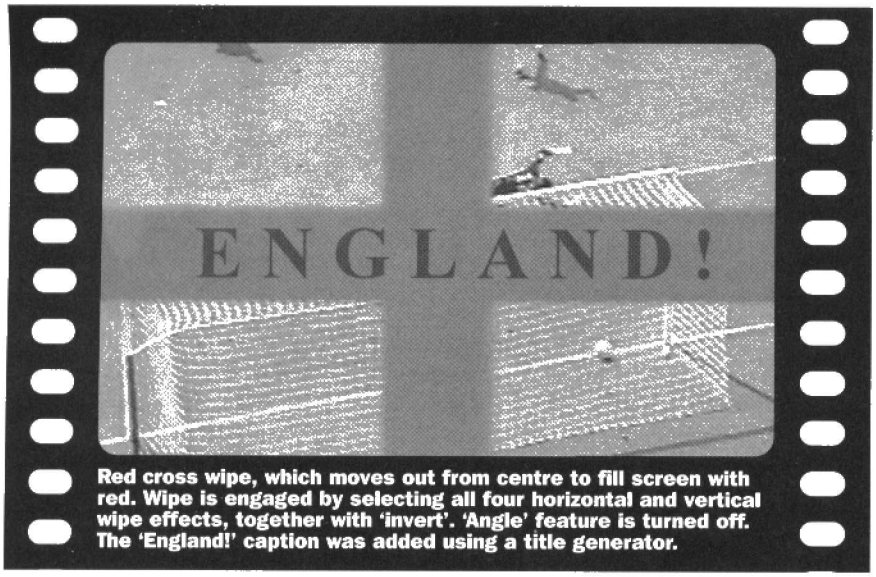
Storyboard 1. Character reading 'How to win Lottery' book in bed.

Storyboard 2. Character turns off bedside lamp.

Storyboard 3. Darkness in bedroom, character falling asleep.



Storyboard 4. The dream! (note use of VP-275).

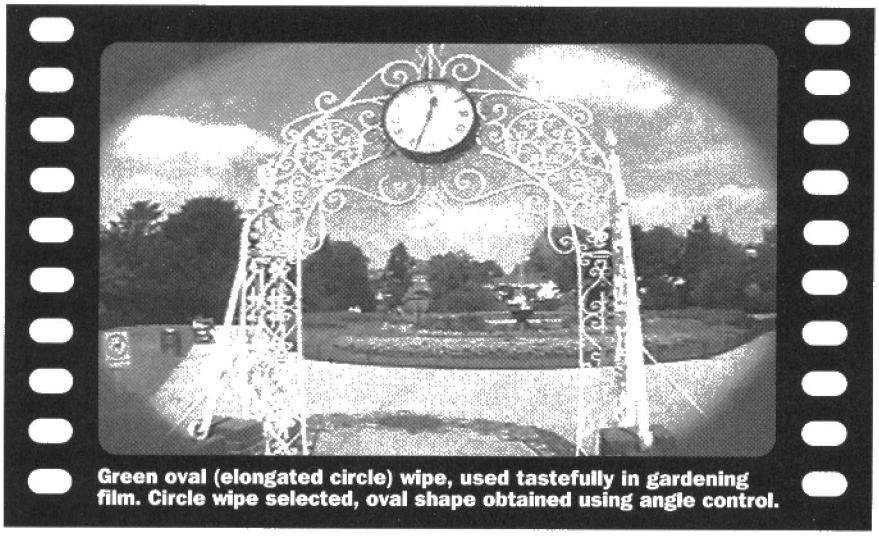


Red cross wipe, which moves out from centre to fill screen with red. Wipe is engaged by selecting all four horizontal and vertical wipe effects, together with 'invert'. 'Angle' feature is turned off. The 'England!' caption was added using a title generator.

Wipes and Fades for the Masses

At a fraction of the price that similar units are selling for, the Datavideo VP-275 (available exclusively from Maplin) is a good but basic special-effects unit that is ideal for the beginner and more advanced users alike. The £180 unit is capable of two basic effect types – fades and wipes. Fades, sometimes included as a feature on camcorders, involve gradually turning the image to black (or some other colour), or vice-versa.

Fading an image (typically a clock face) to black and then fading the image back in again (the clock now displaying a different time) is a device often used to indicate the passage of time. An example of this is where a character waits for somebody – who turns up rather late! The other main use of the fade is at the end of a programme. The black background offers much better contrast for white captions (if you have a title generator).



Green oval (elongated circle) wipe, used tastefully in gardening film. Circle wipe selected, oval shape obtained using angle control.

Wipes are pattern effects, in which one picture is 'wiped out' (i.e. replaced) by another, usually in a horizontal or vertical direction. They are quite popular in Top of The Pops programmes – or at least, the ones that were popular in the 1970s.

Sparingly used, wipes can be used to good effect. Unless you have a desperate need to (some far-out psychedelic music video for a local pub band, perhaps), avoid the temptation to saturate your film with ill-conceived wipes, or the end result will be fatiguing to watch and have a distinctly amateur look.

Wipes are mostly used to make the transition from one video source to another. Unfortunately, this cannot be done with the VP-275, which lacks two video inputs and the timebase corrector that would be required to synchronise them (if you need this feature, you will need a much more expensive unit, such as those produced by Videonics, GSE or Panasonic).

The simpler VP-275 will only wipe to or from a coloured screen – but, as we shall see, there is a lot that can be done with even this. There are many uses for wipes, but generally, they are specific to the kind of project on which you are working – some examples are shown, but at the end of the day, their application is limited only by your imagination.

Introducing the VP-275

Maplin's special effects generator is a compact unit that won't take up much room on your editing bench. The controls are well laid-out, have a reasonable feel and are complemented with a group of indicator LEDs. Round the back are video and audio inputs and outputs. It's good to see that both S-video (4-pin mini-DIN) and composite (RCA/phono) video connectivity is provided.

Low-priced camcorders (VHS-C, 8mm) and VCRs will use the composite video terminals, but higher-performance units (S-VHS or Hi-8) should be used with the S-video terminals to make use of the improved quality potential (higher resolution, etc.). Because both sets of connectors are provided, the VP-275 will accommodate an upgrade.

The provision of phono audio connectors is somewhat superfluous, since the unit won't actually fade audio – you will need an audio mixer for this. Other terminals cater for GPI triggering and DC power input. With the GPI (General Purpose Interface) input, the VP-275 can be automatically triggered to activate a wipe or fade stored in the unit. Some edit controllers offer an GPI trigger pulse output that can be used to drive this feature of the unit. Its inclusion is interesting, since GPI is a (semi) professional feature. With domestic equipment, it is unlikely ever to be used. On the subject of power, the VP-275 needs 12V DC at a current of 500mA. A power supply is not included, but Maplin sell a suitable device – details of which can be found at the end of this article.

Internal construction is good. Inside the VP-275 are two boards. The first one contains the video circuitry, which uses some custom Japanese components as well as a sizeable amount of standard logic chippery. The second board is the main control panel, which is based around a Zilog Z8 microcontroller.

Using the VP-275 – A World of Possibility

There are two main modes of operation (manual and automatic) which are selected by means of a slide switch. In 'manual' mode, you have complete control over the selection and adjustment of the effect. There are eight memory buttons where you can store custom effects achieved in this way. By switching to the 'automatic' mode, these effects can be called up at any time, with a fixed fade or wipe adjustment rate. Such functionality is extremely useful, since you can program (in advance) the effects needed for an editing session.

Let's start with manual effects. Switching between fades and wipes is achieved by pressing the wipe/fade button until the relevant LED is toggled. Fading is the easiest transition. There are a choice of eight background colours (blue, red, magenta, green, cyan, yellow, white and black) to (or from) which you can fade. Colour selection is achieved by pressing the 'color' button cyclically until the most appropriate colour appears – white for a wedding, blue for a holiday, or grey for a mock party political broadcast, perhaps? A large slider to the right of the unit is used to control the fade.

The VP-275's fader does have some other uses. By partially advancing the fader, it is possible to give a coloured tint to the image. It is thus possible to simulate misadjustment of the white balance control that was a feature of older video cameras. This had creative possibilities – you could make the picture take on a slight red tint (giving a picture warmth), or blue tint (making it appear too cold). By selecting the appropriate background colour, such possibilities are open to VP-275 users. Following the same logic, a limited amount of compensation for incorrectly set white balance could be achieved.

There are other uses, too. A black screen can be recorded to give you an edit master – a tape upon which you can insert-edit. Fade out to red, and you have a screen that can be used to check your TV or monitor for purity errors – something that TV engineers often too. Coloured patches could indicate a damaged tube shadow mask, or the nearby presence of a magnetic object – such as an unscreened speaker – which should be removed pronto to avoid long-term damage to the tube! A fade to any of these could be used to give your TV a 'mood' feature, as found, for example, on Panasonic portable sets.

Press the wipe/fade button again, and you're in wipe territory. The patterns are selected by the top row of buttons, which are marked with legends that denote the basic shape (circle or square) and direction of the wipe pattern. By pressing the buttons, you can combine effects to get arrows, diamonds and cross wipe patterns. An invert button changes the direction of the wipe.

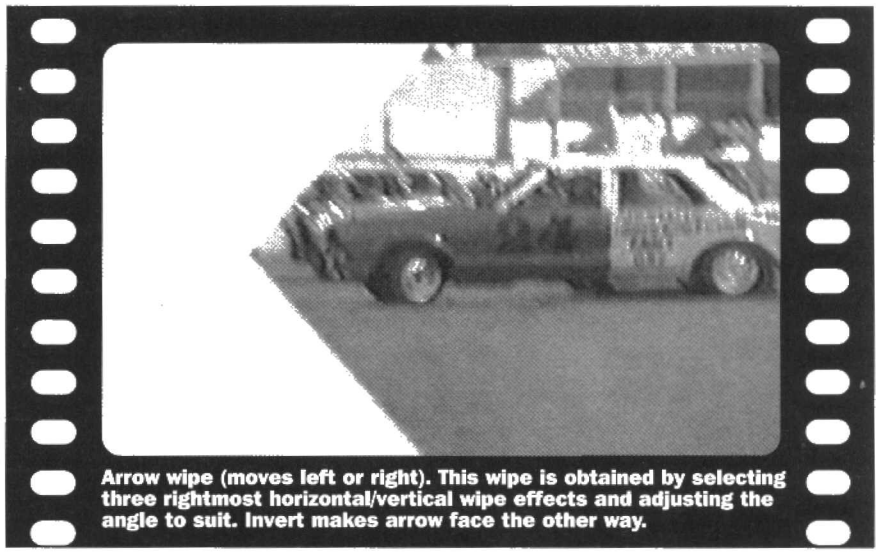
By experimenting with combinations, you can end up with lots of weird and wonderful patterns – a bank of LEDs show which pattern elements have been selected. There is an exception, though. If the circle pattern is selected, it cannot be combined with the effects on the other buttons. Wipes can be programmed to originate from the sides or the centre of the screen.

However, even that's not all. Press the angle button, and you have control of the angle of the wipe using a second slider. You can thus alter the shapes of each pattern – for example, change the circle wipe into an oval. A third slider gives you the opportunity to change the edges of the chosen pattern from sharp to soft. The latter is ideal for use in dream sequences, one of which is illustrated! Theoretically, there is an infinite number of pattern variations that you can get out of this little unit.

By advancing the wipe/fade slide control, the wipe pattern begins to replace the picture with the background colour; retreating it will make the pattern disappear again to reveal more of the picture. Used sensibly, the wipes work well and can give a professional appearance to a production. Some of the images found elsewhere in this review demonstrate how wipes can be used to good effect.

It is unusual to find such a wide range of facilities in such a low price unit. Our criticisms are few. There is occasionally a slight glitch at the beginning of the wipe, but it's not really noticeable. Otherwise, there is no noticeable degradation of the video signal whatsoever. The wipe/fade control is, however, rather coarse in its action, and the complete effect can achieved in a portion of the control's travel. Using the VP-275 thus requires a steady hand.

To store an effect, press the 'learn' key, followed by one of the eight memory buttons. When the VP-275 is switched to automatic mode, pressing the relevant memory button followed by the 'play' key will cause the desired fade or wipe effect to be invoked. Repeating this procedure a second time will cause the effect to 'undo' – in other words, reveal the picture again.



Arrow wipe (moves left or right). This wipe is obtained by selecting three rightmost horizontal/vertical wipe effects and adjusting the angle to suit. Invert makes arrow face the other way.

It is also possible to create automatic sequences of up to eight wipes or fades, which can also be triggered by the GPI input. Our only criticism here is that the memories are non-volatile – unplug the unit, and you will have to program them again (some practical advice – take notes on your favourite combinations of control settings, so that you can return to them).

The disadvantages of this unit are few in number, however, and the VP-275 is capable of adding an extra dimension to your home videos for an affordable outlay. Another interesting fact is that wipe and fade levels are controlled by a variable DC voltage produced by the slide control. This DC voltage could be sourced from external equipment. For example, you could feed it from an audio source, via an op-amp and a diode, to get all kinds of interesting effects. Unfortunately, though, such modifications would invalidate the guarantee, but even in its unmodified state, the VP-275 will help you unlock your creativity if video making is a serious hobby. ELECTRONICS

VP-275 Effects Unit
Order As BJ94C
Normal Price £179.99*H1*, see Subscriber's Offers, inside back cover.

SPECIFICATION

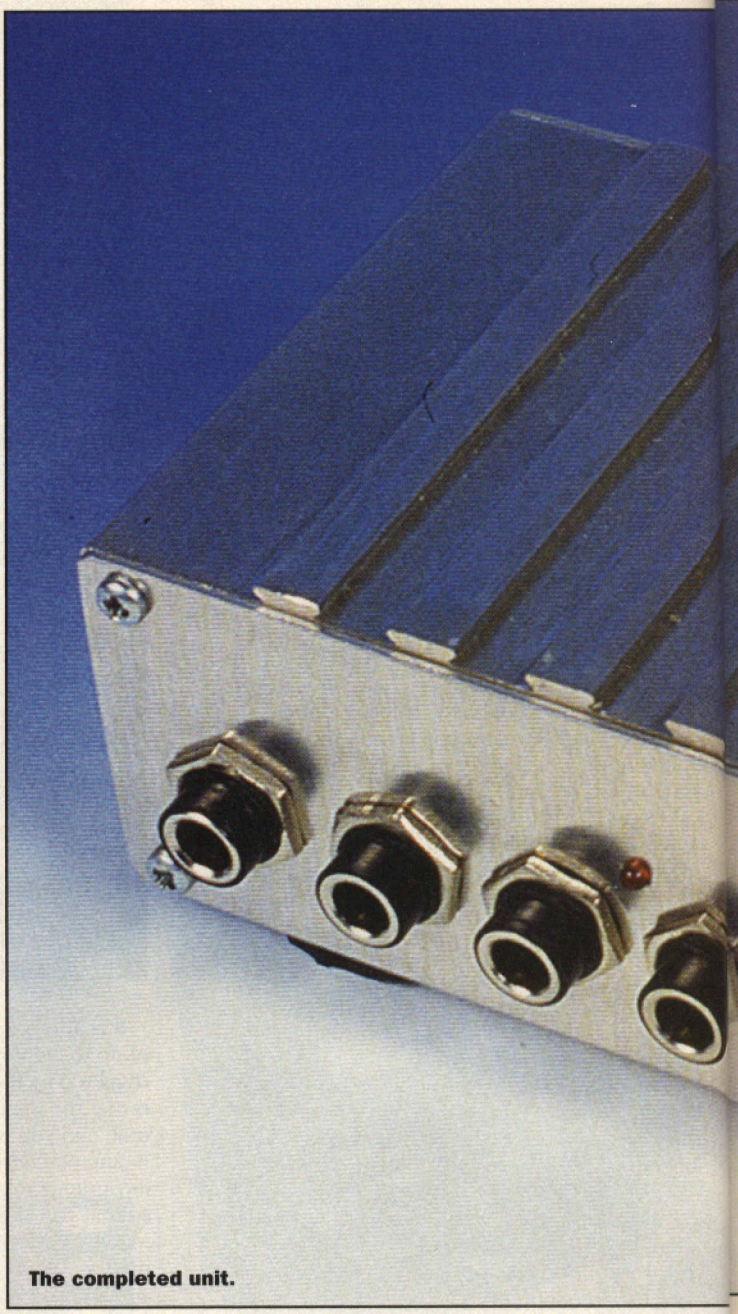
Dimensions:	270 × 170 × 50mm
Weight:	Approximately 1kg
Power requirement:	12V DC regulated, 500mA
Video input:	Composite or S-video (Y/C)
Input impedance:	75Ω
Input level:	1V Pk-Pk
Output gain:	Unity ±1dB (into 75Ω)
Frequency response:	5·5MHz (S-video)
Wipe pattern variations:	Infinite
Wipe functions:	Angle, sharpness, invert, combine functions
Background colours:	8 (red, blue, magenta, cyan, green, yellow, white, black)
Number of effect memories:	8, with 'undo' and 'combination' features

PROJECT

Simple 4-to-1 AUDIO MIXER

Design by Alan Williamson
Text by Alan Williamson and Maurice Hunt

The Simple 4-to-1 Audio Mixer is a functionally basic yet very useful unit that can accept up to four audio inputs and mix (combine) them into one output, with unity voltage gain (zero amplification), for feeding into an audio amplifier, tape recorder, or PA system.



The completed unit.

The mixer is ideal for gigging bands who wish to easily mix the outputs from four instruments so that the resulting combined signal can be boosted via a single amplifier. The mixer also has uses in PA systems, allowing music to be combined with speech, or even for use at karaoke sessions, enabling wannabe pop singers to sing along to the backing track. The unit could additionally be used for sound recording, allowing up to four tracks/samples to be combined into one.

PROJECT RATING 1

Kit Available
Order as 95133
Price £24.99

The unit will operate from either an internal battery or an external DC supply, and indicators are incorporated to show Power On, Low Battery and Signal Overload (clipping). The kit is simple to construct, and comes complete with pre-punched, silk-screen printed front and rear panels for easy construction and a professional appearance. The specified casing, being of extruded aluminium construction, makes the completed Mixer unit extremely durable – perfect for on-stage use.

Circuit Description

The circuit diagram of the project is shown in Figure 1. This type of mixer is known as an Inverting Summing Amplifier, which sums the input currents; it is also known as a Virtual Earth Mixer, because the inverting input is never too far away (voltage wise) from the non-inverting input, which can be treated as earth/ground with a symmetrical dual rail (+/0/–) power supply.

The mixing itself is achieved passively by the resistors R1-R4; the op-amp IC1b merely prevents the junction point (mixed end) of the resistors floating around because it has a virtual input impedance of 0Ω. Resistor R5 provides 100% feedback to cancel the input currents from the input resistors, maintaining the virtual earth input.

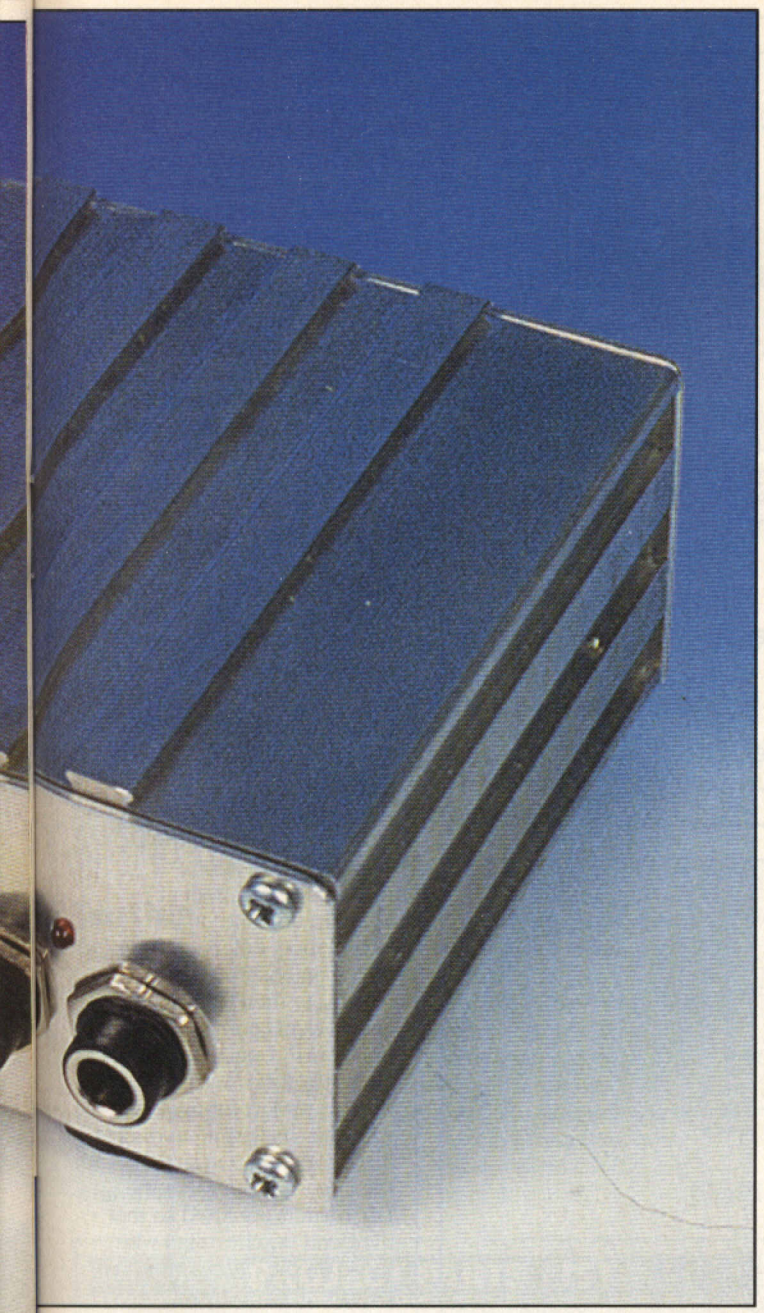
Power for the circuit can be derived from either an external DC supply via SK1 (preferably regulated) or an internal PP3 battery. Inserting a ¼in. jack plug into the 'OUTPUT' socket (SK5) will close the switch contacts, completing the supply circuit.

FEATURES

- Overload, power on and low battery indicators
- Pre-punched, silk-screen printed front and rear panels
- Battery or external PSU operation
- Compact and rugged construction

APPLICATIONS

- Gigging bands
- PA systems
- Karaoke systems



Diode D1 is normally reverse biased across the supply rails, which prevents accidental reverse polarity connections from the external PSU or battery, by clamping the reverse potential to –1V.

This is preferable to a series connected diode, where battery voltage is at a premium – maximum use of the battery must be made because they are not cheap, and the circuit cannot afford the 1V loss (with a near-exhausted battery potential of +7V) and maintain maximum signal headroom at 4V Pk-to-Pk.

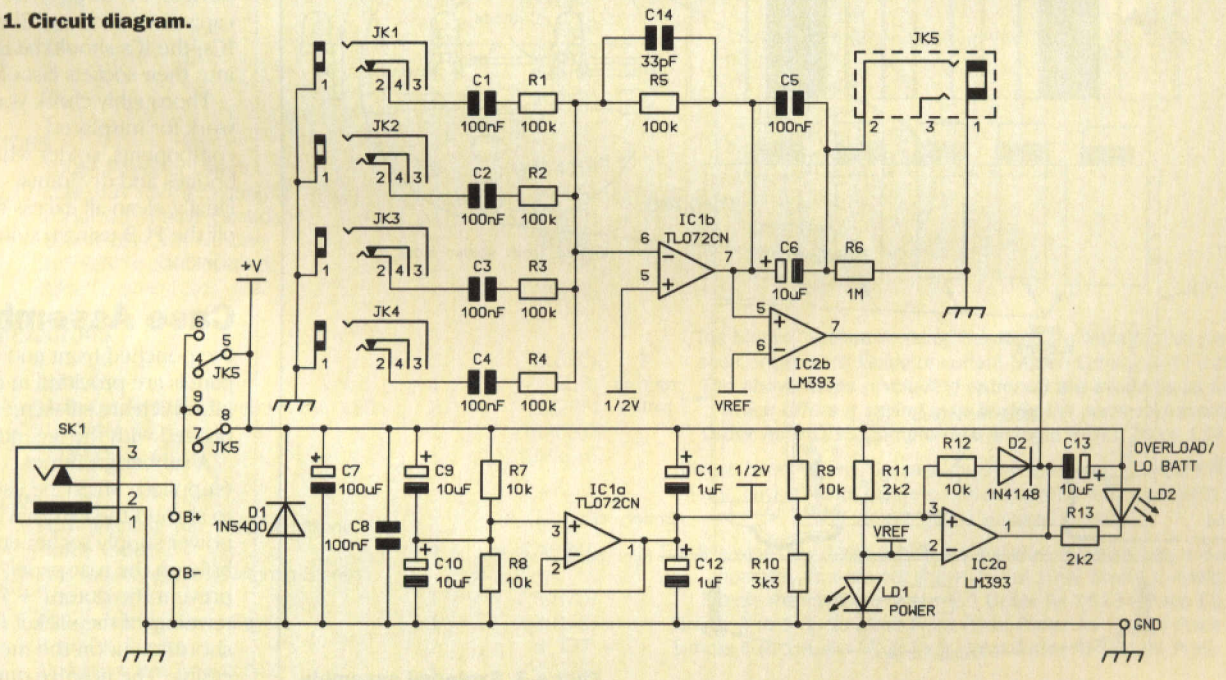
Capacitor C7 provides the main supply decoupling and C8 the high frequency decoupling. The potential divider resistors R7 & R8 form a half supply reference, symmetrically decoupled by the capacitors C9 & C10. The noise free reference is then buffered by IC1a used to generate the low impedance half supply reference ½V; the output of the op-amp is also symmetrically decoupled by C11 & C12 to improve (current) transient behaviour.

IC2 is a dual comparator, half of which is used as a low supply voltage detector; the LED LD1 not only serves as a Power On indicator, but also as a voltage reference for the (–) inverting input of the comparator. The (+) non-inverting input of the comparator is connected to a potential divider, formed by R9 & R10. When the supply voltage drops to approximately +7V, the (+) non-inverting input potential will be below the potential at the (–) inverting input. This will switch ON the comparator output, illuminating LD2 (LD2 also has a dual function, but more on this later); R12 & D2 now come in to play, which are effectively in parallel with R10, reducing the potential even further at the (+) non-inverting input of the comparator. LD1 will only extinguish when the supply voltage is raised above (approximately) +7·5V.

SPECIFICATION

Supply Voltage:	7-15V DC (9V DC nominal); internal PP3 battery or external DC PSU
Current consumption:	8·6mA @ 9V (1kΩ load); <25mA @ 15V
Input impedance:	≈ 100kΩ
Output impedance:	≈ 200Ω
Bandwidth:	20Hz – 130kHz
Distortion:	<0·01% within audio bandwidth
PCB dimensions:	101 × 82mm
Boxed unit dimensions (WHD:	108 × 50 × 93mm

Figure 1. Circuit diagram.



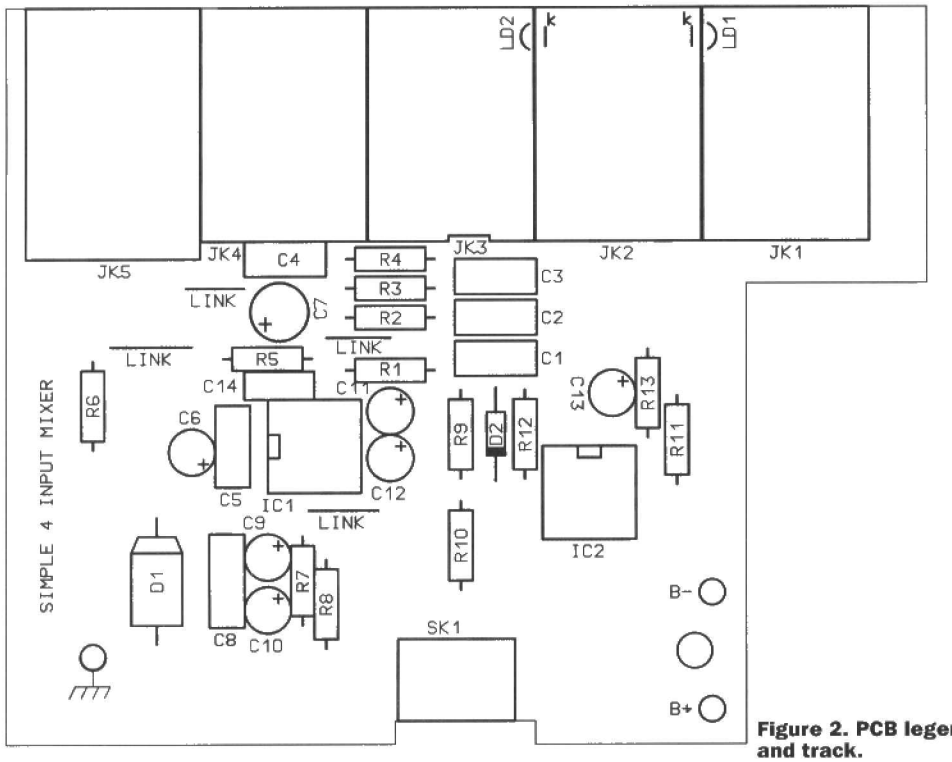


Figure 2. PCB legend and track.

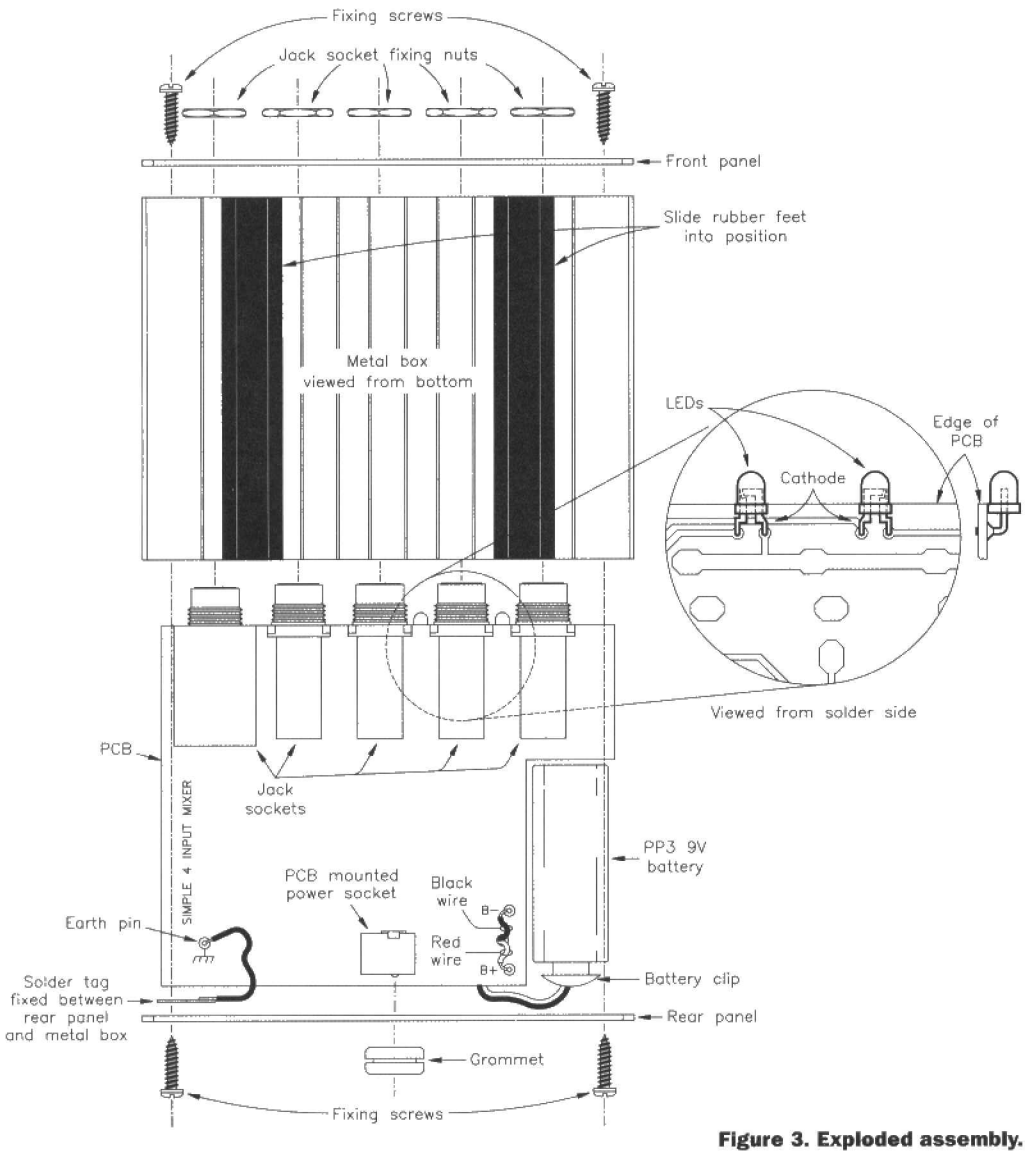


Figure 3. Exploded assembly.

The second half of IC2 forms a simple 'overload' or 'clipping' detector; the comparator compares the output signal from the mixer to the reference voltage (VRef) across LD1. Should the signal come within 1·8V to the ground rail, the comparator output will switch ON, illuminating LD2. However, the duration of the clipping may be very short and may not be 'seen'; adding the capacitor C13 effectively stretches the 'clip pulse' and solves the problem. The LED illuminates just before the onset of clipping, giving advance warning to reduce the input signal(s) or increase the supply voltage (up to 15V maximum), thus preventing avoidable distortion.

PCB Construction

If you are a newcomer to electronic project building, please read the Constructors' Guide supplied with the kit for hints on soldering techniques, component identification and other information, before starting the assembly process.

Refer to the PCB legend and track diagram, shown in Figure 2. Construction is fairly straightforward, hence the low project rating. Begin with the smallest components first, working up in size to the largest. Ensure that the DIL holders are fitted so that their end notches align with those on the printed legend. Be careful to correctly orientate the polarised devices, i.e. electrolytic capacitors, diodes, LEDs and ICs; the ICs should be inserted into their sockets last of all.

Thoroughly check your work for misplaced components, solder whiskers, bridges and dry joints. Finally, clean all excess flux off the PCB using a suitable solvent.

Case Assembly

Pre-punched front and rear panels are provided in the kit, which are silk-screen printed with the legend.

A rubber grommet (supplied) MUST be used to shroud the external power supply socket entrance hole on the rear panel, to prevent the outer ('+') terminal of the socket from shorting out on the metal casing. The positive outer terminal is used to comply

with the power supply socket standard that is used on most modern electronic music equipment/pedals.

Note that a length of moulded rubber strip is supplied in the kit, which is cut to size and can then be slid into grooves on the underside of the box to provide anti-slip/anti-rattle feet. This should be done BEFORE fitting the front and rear panels. Apply a sparing amount of rubberised adhesive (e.g. Bostik), not supplied, to the underside of the strips to permanently attach them, but ensure that the glue is fully dry before using the unit.

Before finally fitting the module into the enclosure, double-check EVERYTHING. Fit the front panel to the PCB, slide the PCB into the box, attach the battery, and fit the rear panel, not forgetting to fit the grounding wire under one fixing screw as shown in Figure 3, the exploded assembly diagram.

Testing

The best way to test the unit is to use it! However, if you have a variable power supply, a signal generator and an oscilloscope, it is worthwhile bench testing it before taking it to a gig.

Refer to Figure 4, showing the typical application wiring diagram for the project.

Set the PSU to +9V and current limit at 0·5A, then connect to the external power socket, SK1 (NOTE, the centre pin of the connector is (–) negative); both LEDs should be extinguished. Insert a jack plug into the 'Output' socket, the 'Power On' LED (LD1) should illuminate; reduce the supply voltage until the 'Low Batt/Clipping' LED (LD2) illuminates, which should be at approximately +7V.

Apply a 4V Pk-to-Pk signal (or if you prefer, a 1·414Vrms or +3dBV) to any input (try them all) and monitor the output; the signal should be just on the edge of clipping.

Slowly increase the supply voltage to +9V, LD1 should extinguish at approximately +7·5V; there should also be a little more signal headroom. If you have a second signal generator, try mixing two different frequency and amplitude signals together.

Please note that the Mixer inverts the input signal(s).

The Simple 4-to-1 Audio Mixer has now been fully tested and is ready for use. Two Mixer units can be used if a stereo mixing system is required, and the specified casings can be interlocked. ELECTRONICS

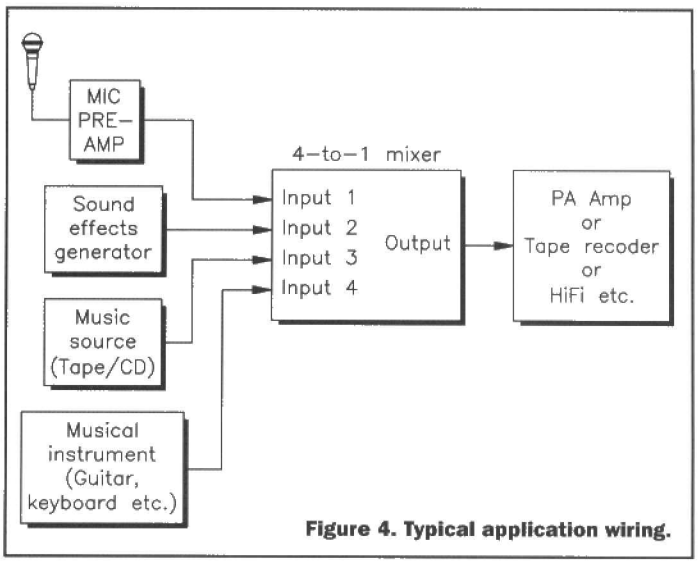
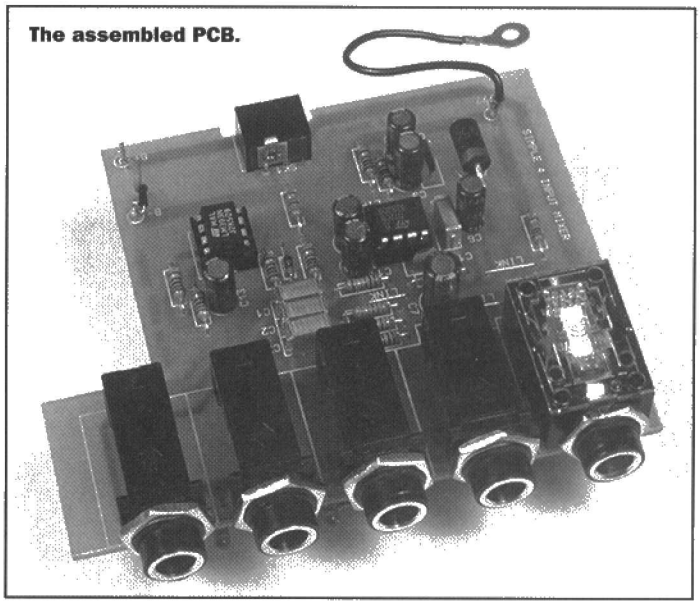


Figure 4. Typical application wiring.

The assembled PCB.



PROJECT PARTS LIST

RESISTORS: All 0·6W 1% Metal Film

R1-5	100k	5	(M100K)
R6	1M	1	(M1M)
R7-9,12	10k	4	(M10K)
R10	3k3	1	(M3K3)
R11,13	2k2	2	(M2K2)

CAPACITORS

C1-5	100nF Polyester Layer	5	(WW41U)
C6,9,10,13	10µF 63V Radial Electrolytic	4	(AT77J)
C7	100µF 16V Radial Electrolytic	1	(AT40T)
C8	100nF 16V Ceramic Disc	1	(YR75S)
C11,12	1µF 63V Radial Electrolytic	2	(AT74R)
C14	33pF Ceramic Disc	1	(WX50E)

SEMICONDUCTORS

D1	1N5400	1	(QL81C)
D2	1N4148	1	(QL80B)
LD1,2	Miniature Red Low Current (2mA) LED	2	(CZ28F)
IC1	TL072CN	1	(RA68Y)
IC2	LM393N	1	(UH30H)

MISCELLANEOUS

JK1-4	PCB-mounting ¼in. Switched Mono Jack Socket	4	(CX89W)
JK5	PCB-mounting ¼in. Switched Stereo Jack Socket	1	(FJ87U)
SK1	PCB-mounting Power Socket	1	(RK37S)
	8-pin DIL Socket	2	(BL17T)
	Aluminium Box Type CCN80	1	(YN50E)
	PP3 Clip	1	(HF28F)
	1mm PCB Pin	1 Pkt	(FL24B)
	6·4mm Standard Grommet	1 Pkt	(JX65V)
	M3 Solder Tag	1 Pkt	(LR64U)
	Rubber Foot	1m	(XR93B)
	7/0·2mm Green Hook-up Wire	1 Pkt	(BL03D)
	PCB	1	(95134)
	Front Panel	1	(95135)
	Rear Panel	1	(95186)
	Instruction Leaflet	1	(XZ26D)
	Constructors' Guide	1	(XH79L)

OPTIONAL

	PP3 Battery	1	(JY49D)
	9V Regulator	1	(BZ84F)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding optional) are available as a kit, which offers a saving over buying the parts separately.

Order As 95133 (Simple 4-to-1 Audio Mixer) Price £24.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue.

Simple 4-to-1 Audio Mixer PCB **Order As 95134 Price £3.49**

Simple 4-to-1 Audio Mixer Front Panel **Order As 95135 Price £2.69**

Simple 4-to-1 Audio Mixer Rear Panel **Order As 95186 Price £1.99**

Electronic FILTER CIRCUITS

PART 1

by Ray Marston

Ray Marston takes an in-depth look at modern electronic filter circuits in this 3-part series.

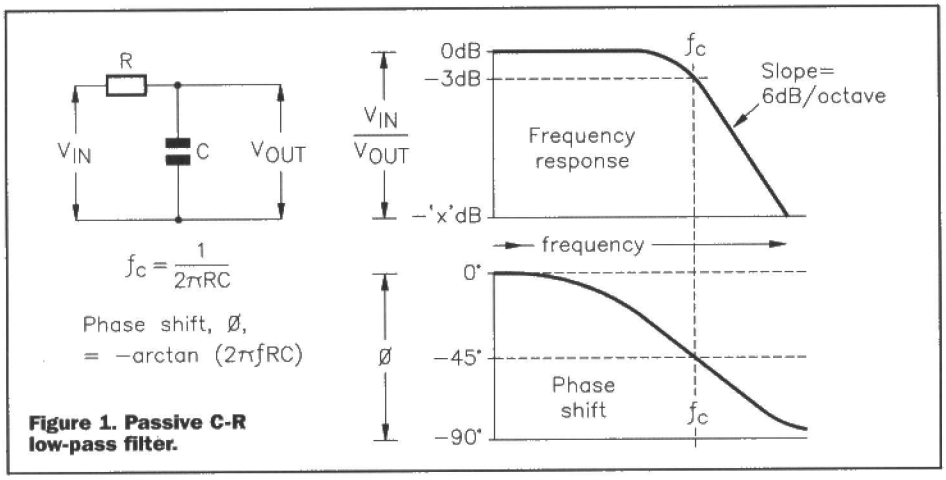


Figure 1. Passive C-R low-pass filter.

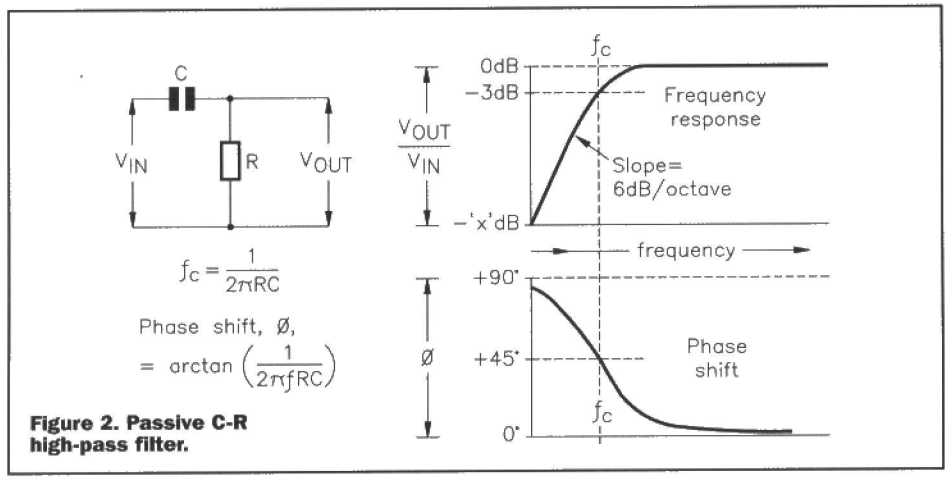


Figure 2. Passive C-R high-pass filter.

C-R and L-C filters are widely used in modern electronics. They can be designed to either accept or reject specific frequencies or frequency bands and to ignore all others. Such filters can consist of nothing more than a number of capacitors and resistors (C-R types), or inductors and capacitors (L-C types), in which case, they are known as 'passive' networks. Alternatively, they can consist of a C-R network combined with transistors or ICs to make what are known as 'active' filters. This opening part of this 3-part feature looks at the design of various C-R passive filters; next month's episode will look at L-C filters, and the concluding part of the series will present a selection of practical 'active' filter circuits. In all three articles, particular attention is given to the use of filters in instrumentation and test gear applications.

Passive C-R Filters

Filter circuits are used to reject unwanted frequencies and pass only those wanted by the designer. In low-frequency applications (up to 100kHz), the filters are usually made of C-R networks, and in high-frequency (above 100kHz) ones, they are usually made of L-C components. The two simplest C-R filters are the basic low-pass and the high-pass types.

A simple C-R low-pass filter (see Figure 1) passes low-frequency signals but rejects high-frequency ones. Its output falls by 3dB (to 70·7% of the input value) at a 'break', 'crossover', or 'cutoff' frequency (f_c) of $1/(2\pi RC)$, and then falls at a rate of 6dB/octave (= 20dB/decade) as the frequency is increased. Thus, a 1kHz filter gives about 12dB of rejection to a 4kHz signal, and 20dB to a 10kHz one. The phase angle (ø) of the output signal lags behind that of the input and equals -arctan $(2\pi RC)$, or –45° at f_c.

A simple C-R high-pass filter (shown in Figure 2) passes high-frequency signals but rejects low-frequency ones. Its output is 3dB down at a break frequency of $1/(2\pi RC)$, and falls at a 6dB/octave rate as the frequency is decreased below this value. Thus, a 1kHz filter gives 12dB of rejection to a 250Hz signal, and 20dB to 100Hz one. The phase angle of the output signal leads that of the input and equals arctan $1/(2\pi fCR)$, or +45° at f_c.

Each of the above two filter circuits uses a single C-R stage and is known as a '1st-order' filter. If a number (n) of such filters are cascaded, the resulting circuit is known as an 'n^{th}-order' filter and has a slope, beyond f_c, of ($n \times$ 6dB)/octave. Thus, a 4th-order 1kHz low-pass filter has a 24dB/octave slope and gives 48dB of rejection to a 4kHz signal and 80dB to a 10kHz one.

In practice, cascaded passive filters are rather difficult to design accurately, due to the disruptive interaction of neighbouring sections, and are rarely used in this simple form; instead, they are effectively cascaded by incorporating them in the feedback networks of suitable op-amps, to make what are known as 'active' filters. One instance where they are used, however, is as the basis of a so-called 'phase-shift' oscillator, as shown in basic form in Figure 3. Here, the filter is inserted between the output and

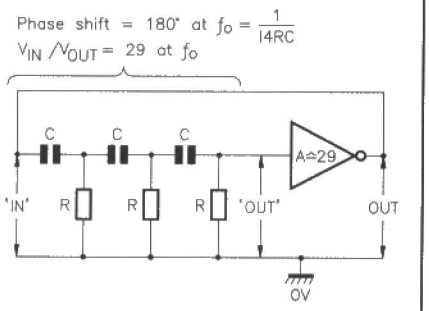


Figure 3. 3rd-order high-pass filter used as the basis of a phase-shift oscillator.

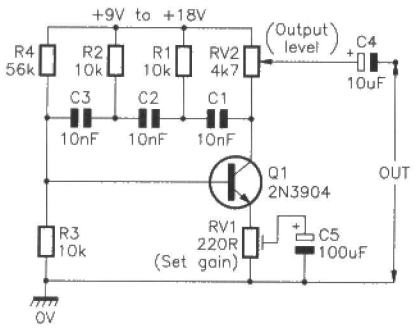


Figure 4. 800Hz phase-shift oscillator.

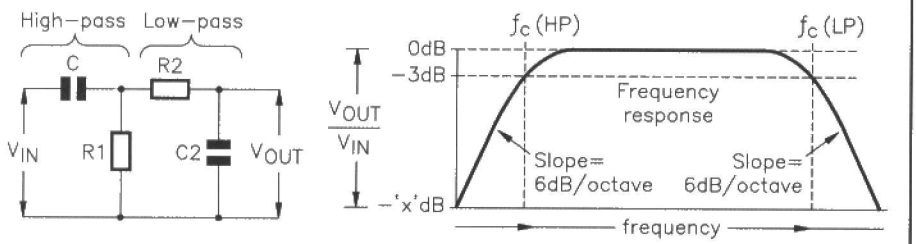


Figure 5. High-pass and low-pass filters cascaded to make a band-pass filter.

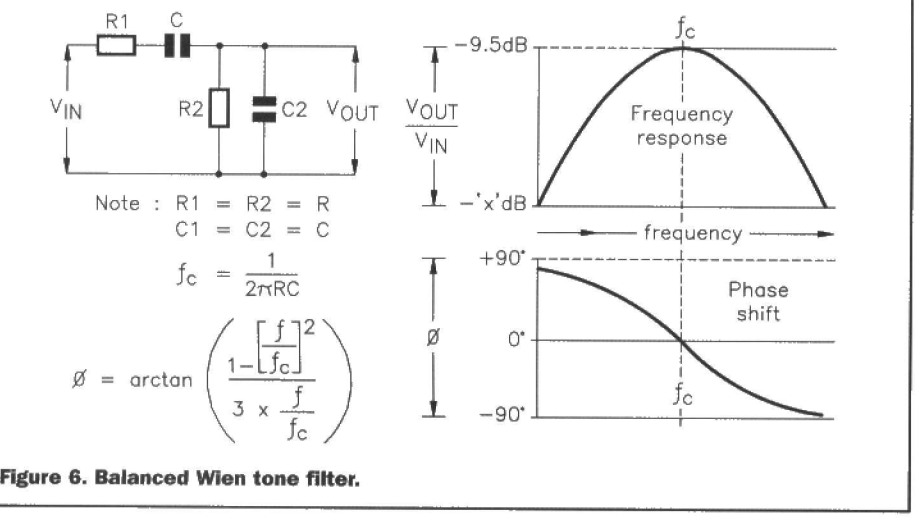


Figure 6. Balanced Wien tone filter.

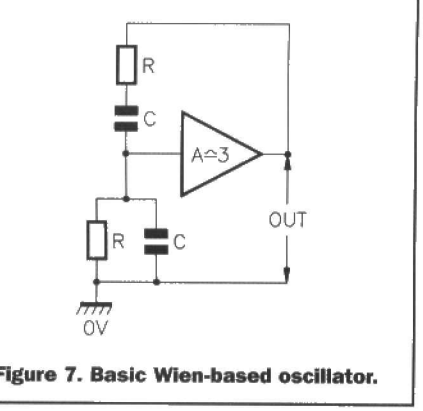


Figure 7. Basic Wien-based oscillator.

input of the inverting (180° phase shift) amplifier; the filter gives a total phase shift of 180° at a frequency, f_o, of about 1/(14RC), so the complete circuit has a loop shift of 360° under this condition and will thus oscillate at this frequency if the amplifier has sufficient gain (about ×29), to compensate for the losses of the filter and thus give a loop gain greater than unity.

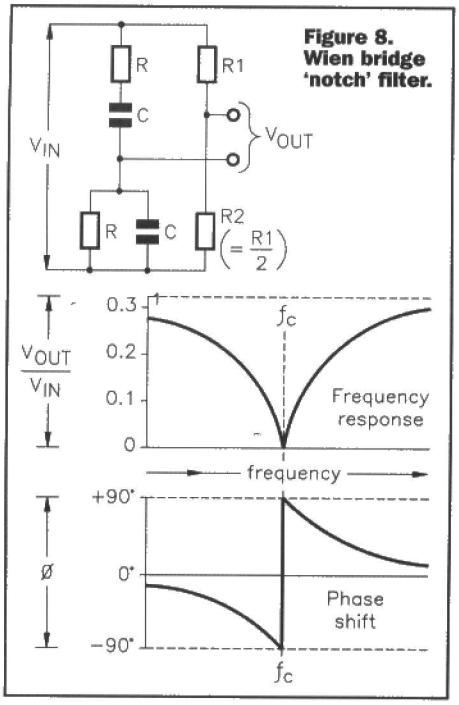


Figure 8. Wien bridge 'notch' filter.

Figure 4 shows a practical example of a 800Hz version of the phase-shift oscillator. RV1 must be adjusted to give reasonable sine wave purity; the output level is variable via RV2.

Band-pass and Notch Filters

A 'band-pass' filter is one that accepts a specific band or spread of frequencies but rejects or attenuates all others. A simple version of such a circuit can be made by cascading a pair of C-R high-pass and low-pass filters, as shown in Figure 5. The high-pass component values determine the lower break frequency, and the low-pass values set the upper break frequency.

Note that if the two filters in the above circuit are given the same break frequency value, the circuit becomes a tone-select filter, which gives minimum attenuation to a single frequency. Figure 6 shows a popular variation of this type of circuit, the Wien tone filter. R1 & R2 and C1 & C2 normally have equal values in this circuit, in which case, the circuit is said to be a 'balanced' type. The balanced Wien filter gives an attenuation factor of 3 (= –9·5dB) at f_c; the circuit's major feature is that its output phase shift varies between +90° and –90°, and is precisely 0° at f_c. Consequently, the circuit can be used as the basis of a sine wave generator by simply connecting its output back to its input via a non-inverting amplifier with a gain of ×3 (to give a loop gain of unity), as shown in basic form in Figure 7.

A 'notch' filter is one that gives total rejection of one specific frequency, but accepts all others. Such a filter can be made by wiring the Wien network into the Bridge configuration shown in Figure 8. Here, R1 & R2 act as a voltage divider with a nominal attenuation factor of 3; consequently, the voltage divider and the Wien filter outputs are identical at f_c, and the output (which equals the difference between the two signals) is thus zero under this condition. In practice, the value of R1 or R2 must be carefully trimmed to give precise nulling at f_c.

The Wien Bridge network can be used as the basis of an oscillator by connecting it as in Figure 9 (a). At first glance, it might seem here that the Wien's output is fed to the input of a high-gain differential amplifier that has its output fed back to the Wien's input, to complete a positive feedback loop. When the circuit is redrawn as in Figure 9 (b), however, it becomes clear that the op-amp is actually used as a ×3 non-inverting amplifier, and that this circuit is similar to that of Figure 7. In reality, these circuits must be fitted with some form of automatic gain control if they are used to generate good-quality sine waves.

A major feature of the Wien Bridge network is that its tuned frequency can easily be changed by simultaneously altering its two R or C values. Figure 10 shows this facility used to make a wide-range (15Hz to 15kHz) variable notch filter, in which fine tuning and decade switching are available via RV1 and SW1, and null trimming is available via RV2.

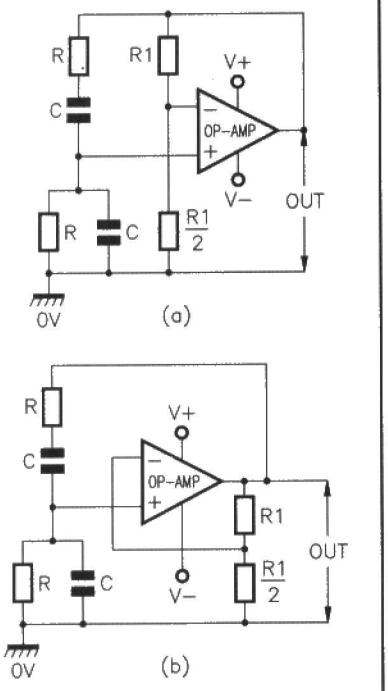


Figure 9. The Wien bridge oscillator in (a) is the same as that of (b).

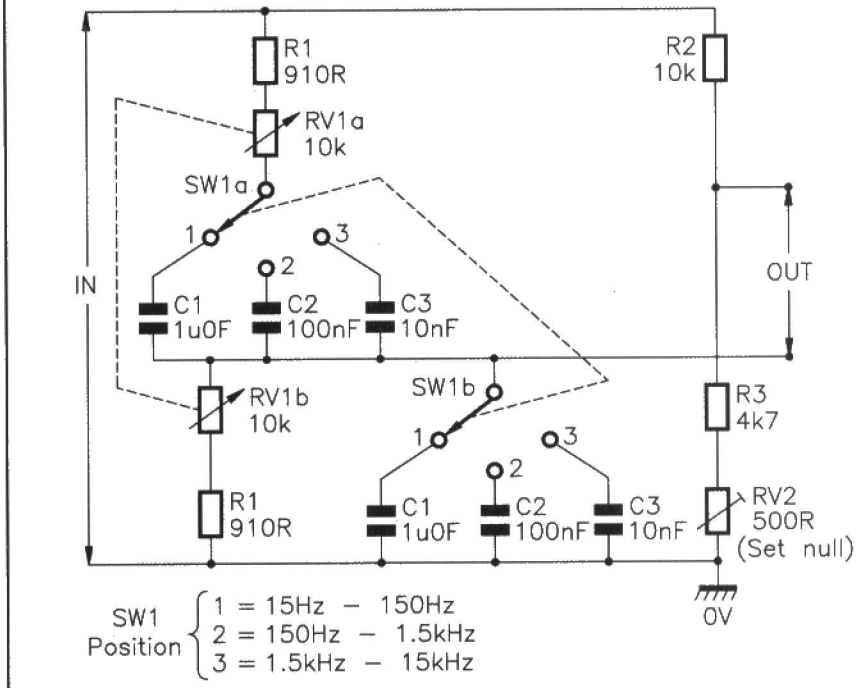


Figure 10. Variable frequency (15Hz to 15kHz) Wien Bridge notch filter.

The 'Twin-T' Filter

Figure 11 shows another version of the notch circuit, the 'twin-T' filter. Major advantages of this filter are that (unlike the Wien Bridge type) its input and output signals share a common 'ground' connection, and its off-frequency attenuation is less than that of the Wien. Its major disadvantage is that, if its tuning is to be made fully variable, the values of all three resistors (or capacitors) must be varied simultaneously. This filter is said to be a 'balanced' type when its components have the precise ratios shown; to obtain perfect nulling, the R/2 resistor value needs careful adjustment. Note in particular, that the circuit gives zero phase shift at f_c.

One weakness of the twin-T filter is that (like the Wien type) it has a very low effective 'Q' (quality) factor. Q is defined as being the f_c value divided by the bandwidth between the two –3dB points on the filter's transmission curve, and in this case, equals 0·24. What this means in practice, is that the filter subjects the second harmonic of f_c to 9dB of attenuation, whereas an ideal notch filter would give it zero attenuation. This weakness can easily be overcome by 'bootstrapping' the common terminal of the filter, as shown in basic form in Figure 12. This technique enables high effective Q values to be obtained, with negligible attenuation of the second harmonic of f_c.

The action of the balanced twin-T filter is fairly complex, as indicated by the operational representation of it, shown in Figure 13. It consists of a parallel-driven low-pass $f_c/2$ and a high-pass $2f_c$ filter, with their outputs joined by an R-C 'f_c' voltage divider. This output divider loads the two filters and affects their phase shifts, the consequence being that the signals at points A and B have identical amplitudes but have

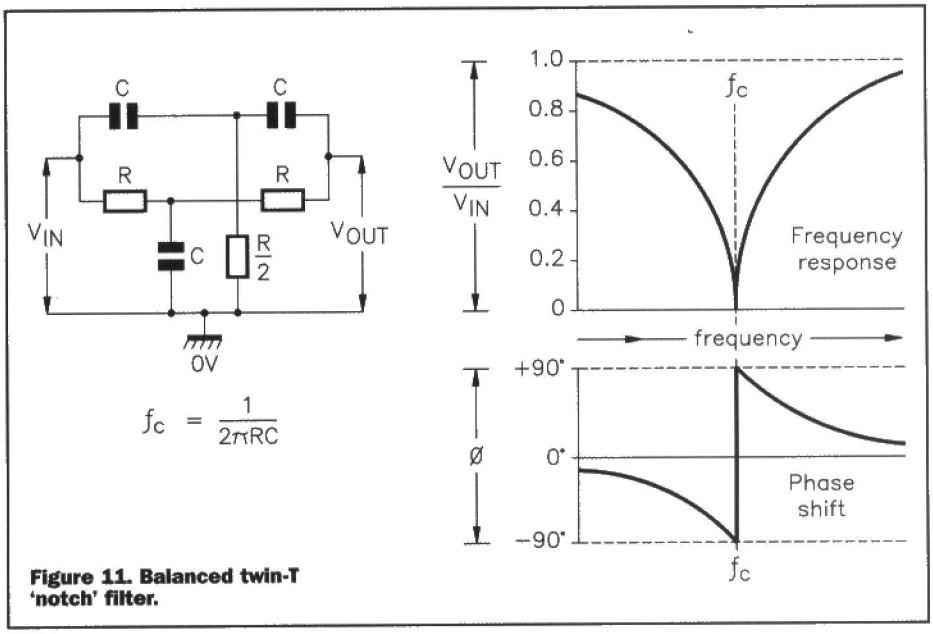


Figure 11. Balanced twin-T 'notch' filter.

phase shifts of –45° and +45° respectively at f_c; simultaneously, the impedances of the R and C sections of the output divider are identical, and give a 45° phase shift at f_c. Consequently, the divider effectively cancels the two phase differences under this condition and gives an output of precisely zero, this being the phase-cancelled difference in amplitudes of the two signals.

Thus, a perfectly balanced twin-T filter gives zero output and zero phase shift at f_c. At frequencies just below f_c, the output is dominated by the actions of its low-pass filter, and is phase-shifted by –90°; at frequencies just above f_c, the output is dominated by the actions of its high-pass filter, and is phase shifted by +90° (see Figure 11).

An 'unbalanced' version of the twin-T filter can be made by giving the 'R/2' resistor a value other than the ideal. If this resistor has a value greater than R/2, the circuit can be said to be positively unbalanced; such a circuit acts in a manner similar to that described, except that its notch has limited depth; it gives zero phase shift at f_c. If, on the other hand, the resistor has a value less than R/2, the circuit can be said to be negatively unbalanced; such a circuit also produces a notch of limited depth, but has the useful characteristic of generating a phase-inverted output, thus giving a 180° phase shift at f_c, as shown in Figure 14.

Figure 15 shows how a negatively unbalanced twin-T notch filter can be used to make a 1kHz oscillator or a tuned acceptance filter. The twin-T filter is simply wired between the input and output of the high-gain inverting amplifier, so that a loop shift of 360° occurs at f_c. To make the circuit oscillate, RV1 is adjusted so that the twin-T notch gives just enough output to give the

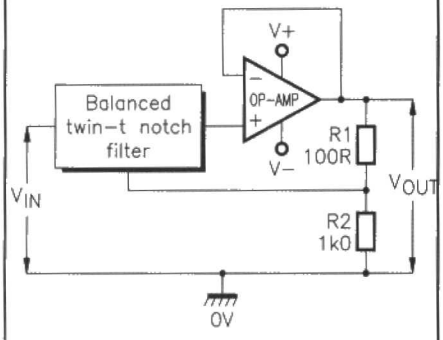
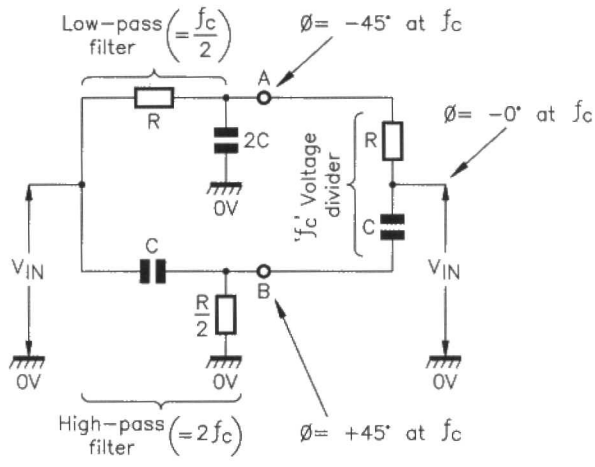


Figure 12. Bootstrapped high-Q notch filter.

Figure 13. Operational representation of the balanced twin-T filter.



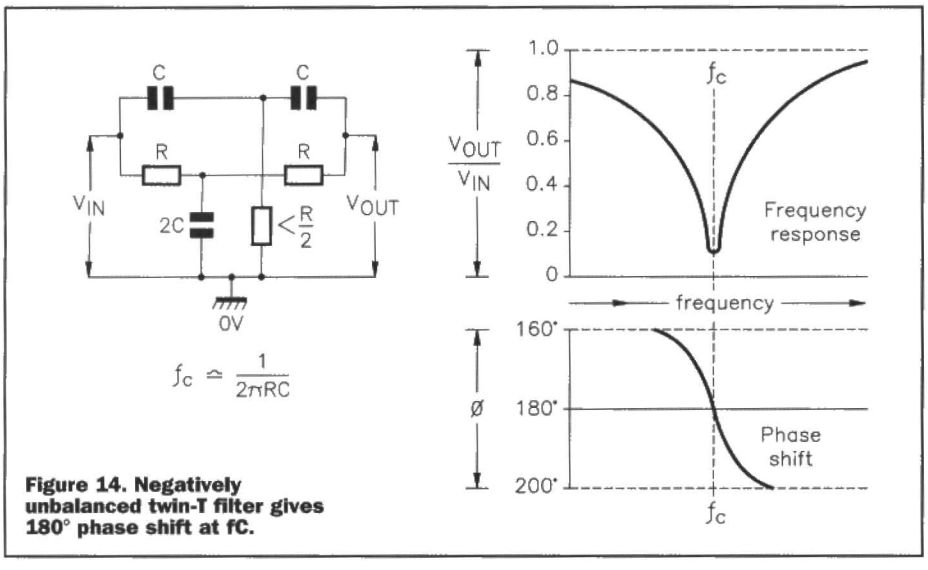


Figure 14. Negatively unbalanced twin-T filter gives 180° phase shift at fC.

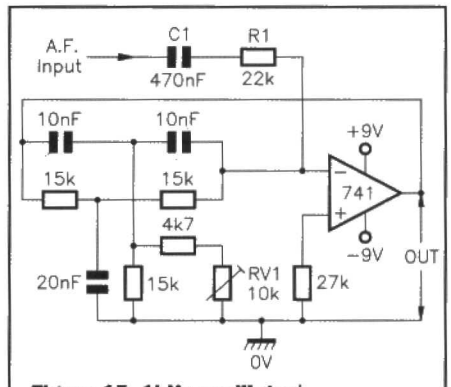


Figure 15. 1kHz oscillator/ acceptance-filter using negatively unbalanced twin-T network.

$$f_c = \frac{1}{2\pi RC} \qquad R = \frac{1}{2\pi f_c C} \qquad C = \frac{1}{2\pi f_c R}$$

f_c = kHz, R = kΩ, C = μF

Figure 16. Formulae for finding the component values of single-stage high-pass or low-pass C-R filters and balanced Wien or twin-T networks.

system a loop gain greater than unity; the circuit generates an excellent sine wave under this condition. To make the circuit act as a tone filter, RV1 is adjusted to give a loop gain less than unity, and the audio input signal is fed in via C1 and R1; under this condition, R1 and the twin-T filter interact to form a frequency-sensitive circuit that gives heavy negative feedback and low gain to all frequencies except f_c, to which it gives little negative feedback and high gain; the tuning sharpness is variable via RV1.

C-R Component Selection

Single-stage C-R low-pass and high-pass filters and balanced Wien and twin-T networks all use the same formula to relate the f_c value to that of R and C, i.e., $f_c = 1/(2\pi RC)$. Figure 16 shows, for quick reference purposes, this formula transformed to enable the values of R or C to be determined when f_c and one component value is known. When using these formulae, it is often easiest to work in terms of kHz, kΩ, and μF, as indicated. ELECTRONICS

ELECTRONICS Classified

Placing an advertisement in this section of *Electronics* is your chance to tell the readers of Britain's Best Selling Electronics Magazine what you want to buy or sell, or tell them about your club's activities – Absolutely Free of Charge! We will publish as many advertisements as we have space for. We will print the first 30 words free, but thereafter the charge is 10p per word for each added advert per reader.

Placing an advertisement is easy! Simply write your advertisement clearly in capital letters, on a postcard or sealed-down envelope. Then send it, with any necessary payment, to: *Electronics Classified*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

Advertisements will be published as soon as possible, space allowing. No responsibility is accepted for delayed publication or non-inclusion of advertisements.

Readers who have reasonable grounds to believe they have been misled as to the nature of an advertisement are advised to contact the Publisher and their local Trading Standards Office.

Computers

ALTOS IV Dumb Terminals with keyboard, RS-232 port with selection of baud rates. £5 each. Tel: (01689) 821885.

Completed Computer Projects e.g., Z80 CPU, Sonar boards, I/O boards, lucky dip (contains chips/boxes/components, £2 including P&P. SAE for list to: A. Morell, 12 Boscobel Road, Winchester S022 6RY.

Various

***Electronics – The Maplin Magazine* Back Issues** for sale. December 1987 to March 1996. Offers invited. Tel: (0181) 643 5077.

Crotech 25MHz Dual Trace Oscilloscope Model 3133. Needs to be calibrated. £110. Tel: (01827) 282227.

Hameg HM303 Dual-Channel 30MHz Oscilloscope. Unwanted prize, two weeks old, never used and still in box. List price £495, yours for £395 o.n.o. Tel: (01751) 432405 (evenings).

Micronta 22-195 Digital Multimeter lab standard, £40. Sollatek resistance decade box to 100kΩ, £35. RSD, TTL/CMOS logic checkers, 14-16 DIL ICs, £45 each. Tel: Swansea (01792) 588647.

Monochrome Video Monitors, over 20 units, all working, many less than 6 months use. Mostly large screens – ideal for CCTV. Many incorporate sound channels. £1,000 the lot, could deliver. Tel: (01400) 230639.

Oscilloscope Iso-Tech ISR 620, dual 20MHz, one ×10 probe, good working condition, little used. £175. Tel: (01277) 224581 (Brentwood, Essex).

PCBs for Dynamic Range Processor Project (see Issue 103), £10 each (UK postage included, overseas £2 postage). Send SAE for details: Paul Stenning, 1 Chisel Close, Orchard Glade, Hereford HR4 9XF.

Radio and Television Servicing Models 1969 to 1974 in 6 volumes. Mint condition. £45 o.n.o. Tel: (01892) 533569.

Shed Clearout! Lots of very cheap electronic components for sale. Send SAE for list to: M. Knight, 10 Daniel Road, Mancetter, Atherstone, Warks. CV9 1PA.

Wanted

Circuit Diagrams for Sinclair black and white pocket TV. Tel: Paul (01235) 771980.

Synthesizer Enthusiast seeks SSM, Curtis chips, prebuilt projects (E&MM, Digisound, Formant, etc.), diagrams, info, anything. Have some diagrams to exchange or just call to chat! Brian, Tel: (01268) 559284.

UA726C, SN76477, SSM20xx, CEM33xx Chips. Also any Digisound/Aries modules or similar, can swap for other components or cash. Tel: Chris (01235) 534152 (evenings, Oxon).

Club Corner

ARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (CM0JCN), Tel (01569) 731177.

The British Amateur Electronics Club (founded in 1966), for all interested in electronics. Four newsletters a year, help for members and more! UK subscription £8 a year (Junior members £4, overseas members £13.50). For further details send S.A.E. to: The Secretary, Mr. J. F. Davies, 70 Ash Road, Cuddington, Northwich, Cheshire CW8 2PB.

Bury St. Edmunds Amateur Radio Society. Meetings held at Culford School, 7.30pm for 8.00pm on the third Tuesday of each month, unless otherwise stated. Further details from Kevin Waterson, (G1GVI), 20 Cadogan Road, Bury St. Edmunds, Suffolk IP33 3QJ. Tel: (01284) 764804.

Crystal Palace and District Radio Society meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, (G3DSC), Tel: (0181) 699 5732.

Derby and District Amateur Radio Society meets every Wednesday at 7.30pm, at 119 Green Lane, Derby. Further details from: Richard Buckby, (G3VGW), 20 Eden Bank, Ambergate DE56 2GG. Tel: (01773) 852475.

Electronic Organ Constructor's Society. Details of programme magazine and membership from: Don Bray (Hon. Sec.), 34 Etherton Way, Seaford, Sussex BN25 3QB. Tel: (01323) 894909.

E.U.G. User group for all 8-bit Acorn Micros, since 1991. Still going strong. Programming, news, information, sales. Contact: E.U.G., 25 Bertie Road, Southsea, Hants. PO4 8JX. Tel: (01705) 781168.

The Lincoln Short Wave Club meets every Wednesday night at the City Engineers' Club, Waterside South, Lincoln at 8pm. All welcome. For further details contact Pam, (G4STO) (Secretary). Tel: (01427) 788356.

Model Railway Enthusiast? How about joining 'MERG', the Model Electronic Railway Group. For more details contact: Paul King (Honorary Secretary), 25 Fir Tree Way, Hassocks, West Sussex BN6 8BU.

Preston Amateur Radio Society meets every Thursday evening at The Lonsdale Sports and Social Club, Fulwood Hall Lane, Fulwood, (off Watling Street Road), Preston, Lancashire PR2 4DC. Tel: (01772) 794465. Secretary: Mr Eric Eastwood, (G1WCQ), 56 The Mede, Freckleton PR4 1JB, Tel: (01772) 686708.

Science At Your Fingertips. Want to meet friends interested in Science? Send an SAE to: Daniel Gee, S.A.Y.F., 37 South Road, Watchet, Somerset TA23 0HG, or Scott Mason, S.A.Y.F., 58 Park Avenue, Devonport, Plymouth PL1 4BP.

SEEMUG (South East Essex Mac User Group), meet in Southend, every second Monday of each month. For details Tel: Michael Foy (01702) 468062, or e-mail to mac@mikefoy.demon.co.uk.

Southend and District Radio Society meets at the Druid Venture Scout Centre, Southend, Essex every Thursday at 8pm. For further details, contact: P.O. Box 88, Rayleigh, Essex SS6 8NZ.

Sudbury and District Radio Amateurs (SanDRA) meet in Gt. Cornard, Sudbury, Suffolk at 8.00pm. Visitors and new members are very welcome. Refreshments are available. For details please contact Tony, (G8LTY), Tel: (01787) 313212 before 10.00pm.

TESUG (The European Satellite User Group) for all satellite TV enthusiasts! Totally independent. TESUG provides the most up-to-date news available (through its monthly 'Footprint' newsletter, and a teletext service on the pan-European 'Super Channel'). It also provides a wide variety of help and information. Contact: Eric N. Wiltsher, TESUG, P.O. Box 576 Orpington, Kent BR6 9WY.

Thanet Electronics Club. For school age Ham Radio and Electronics enthusiasts, enters its 16th Year. Meetings held every Monday evening from 7.30pm at The Quarterdeck, Zion Place, Margate, Kent. For further details contact: Dr. Ken L. Smith, (G3JIX), Tel: (01304) 812723

Wakefield and District Radio Society meet at 8.00pm on Tuesdays at the Community Centre, Prospect Road, Ossett, West Yorkshire. Contact Bob Firth, (G3WWF), (QTHR), Tel: (0113) 282 5519.

The (Wigan) Douglas Valley Amateur Radio Society meets on the first and third Thursdays of the month from 8.00pm at the Wigan Sea Cadet HQ, Training Ship Sceptre, Brookhouse Terrace, off Warrington Lane, Wigan. Contact: D. Snape, (G4GWG), Tel: (01942) 211397 (Wigan).

Winchester Amateur Radio Club meets on the third Friday of each month. For full programme contact: G4AXO, Tel: (01962) 860807.

Wirral Amateur Radio Society meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the the first and third Wednesday of every month. Details: A. Seed, (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE.

Wirral and District Amateur Radio Society meets at the Irby Cricket Club, Irby, Wirral. Organises visits, DF hunts, demonstrations and junk sales. For further details, please contact: Paul Robinson, (G0JZP) on (0151) 648 5892.

ELECTRONICS CORRIGENDA

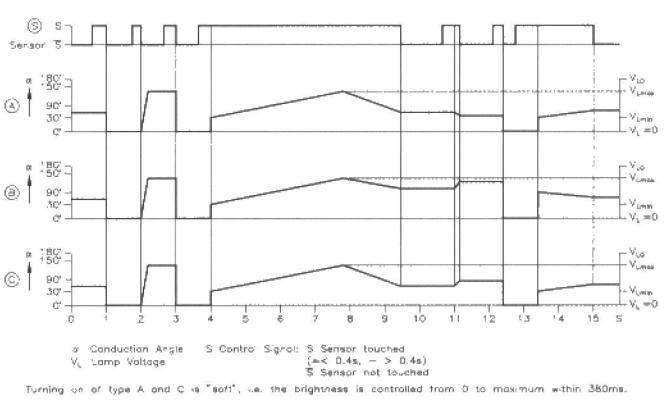
July 1996/Issue 103

Pattress Mounting Dimmer Switch **Page 10**

Turning ON/OFF: In this section, the timing diagram referred to on page 10, and a summary of operation, were unfortunately omitted, and are reproduced to the right.

Link Setting	Operation
A	Soft switch-on within 380ms. Starts from minimum brightness. Dims in same direction until minimum/maximum level is reached then dims in opposite direction.
B (default)	Switches on to previous light level setting. Alternate dimming direction.
C	Soft switch-on within 380ms. Starts from minimum brightness. Alternate dimming direction.

Summary of Dimmer Switch Operation.



α Conduction Angle S Control Signal: S Sensor touched (=< 0.4s, – > 0.4s)
V_L Lamp Voltage S Sensor not touched

Turning on of type A and C is "soft", i.e. the brightness is controlled from 0 to maximum within 380ms.

Navigator 3.0 Browser from NETSCAPE

by Stephen Waddington

Embedded audio, video, 3D images and a virtual reality environment accessed over the Web are all the promise of Netscape's next generation browser. Here, Stephen Waddington downloads the beta version of Navigator 3.0, and takes a first look.

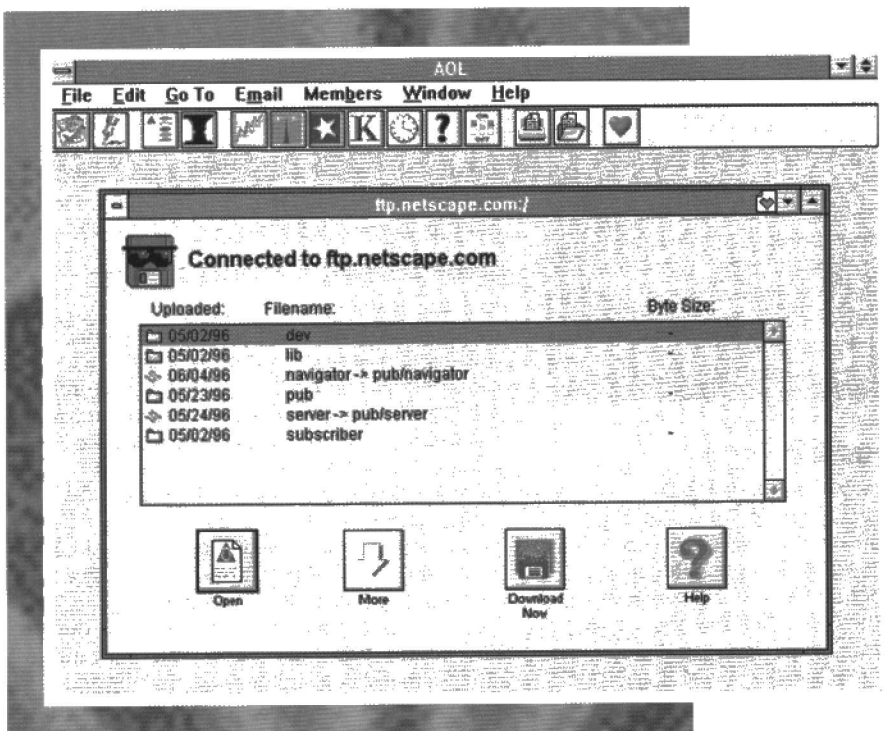


Photo 1. Netscape FTP site.

It used to be the case that the life cycle of a product in the IT industry was three to four years. At least, that's the length of time which Sinclair's ZX81, and Amstrad's PCW 8256 lasted before the IBM PC made moves into the consumer market. Microsoft with Windows '95, and Windows '97 promised next year, along with Intel and its Pentium and Pentium Pro, has squeezed product life cycles to around 18 months.

But now, Netscape is pushing timescales even further to the limit. Six months after the company launched the second version of its Web browser Netscape Navigator 2.0, it has announced a third version. By the time we went to press, version 3.0 was in its fourth Beta version, with final product slated for August. The motivation behind Netscape's continual iteration is probably more due to the pace of innovation and growth of the Internet itself, rather than a desire (or need) to charge customers for new versions of software or upgrades.

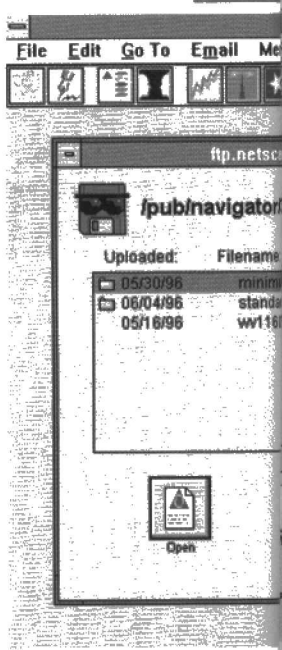
Navigator 3.0 beta looks very much like Navigator 2.0. All the familiar commands and buttons are in place. What is different, is the software embedded behind the browser. Navigator 3.0 is tightly integrated, adding integrated video, audio, 3D graphics and Internet telephone capabilities. Many of the additional plug-in features of Navigator 2.0 that enable audio and video to be handled directly off the Web page are a standard feature of Navigator 3.0. Meanwhile, existing features such as JavaScript, security and disk-cache have been enhanced.

Downloading the Software

The single user version of Navigator 3.0 is available free. It can be downloaded straight off the Netscape home page at **`http://home.netscape.com`**, or alternatively, the Netscape FTP site at **`ftp://ftp.netscape.com`**. Having personally attempted to download Navigator 3.0 off the Netscape homepage via both CompuServe and AOL, and failed on both occasions because of errors during transmission, I can recommend that the FTP site is definitely the better option.

The single user version of Navigator 3.0 beta is available in four flavours: UNIX, Apple, Windows 16-bit and Windows 32-bit. The minimum installation details for each platform are shown in Table 1. In each case, there is approximately 6 to 9M-byte of code to download. This will takes 90 minutes using a 14.4 modem with a clean line connection, or around half that time with a 28.8 modem. If you experience sludgy transmission speeds, disconnect and try again. It's worth spending the time initially to get a good connection.

When you log onto to the Netscape FTP site, you need to drill down through the directories as shown in Photo 1, until you find the version of the software you require. Netscape 3.0 beta is located at: **`ftp://ftp.netscape.com:/pub/navigator/3.0/3.0b4/`**. From here, it's a case of selecting the format you require. In each instance, two versions of the software are available for each platform type: minimum and standard – as shown in Photo 2. To experience all the new features of Navigator 3.0, you need the standard version. The minimum version lacks the plug-in multimedia features that enable users to take advantage of Web pages with embedded audio and video.



Once Navigator 3.0 file is downloaded, it should be installed in the same manner that any new software is installed. It's worth a brief aside here, to comment on the fact that this is the manner in which software will be distributed in the future. Some manufacturers, like Netscape, are already using this method to distribute demo or shareware versions of their software. Before long, complete software packages will be available over the Internet, with payment handled by credit card, either over the Internet or by telephone.

This could mean a change in momentum for software distribution. Instead of buying the latest version of Microsoft Word or Excel from PC World, it will be downloaded from the Internet. This could mean a reduction in the cost of software, as the requirement for packaging and production of CD ROMs and manuals is eliminated. Manuals will also be available over the Internet. In the case of Navigator 3.0, an indexed manual is available at **http://home.netscape.com/eng/mozilla/3.0/handbook/**, as shown in Photo 3. This includes information on how to configure the browser and get started. Detailed tutorials and reference guides allow users to quickly grasp the fundamentals of Navigator 3.0. An alphabetical index of functions is also provided.

Connecting to the Internet

A direct Internet connection to the Internet is required before using Navigator 3.0. The ability to send and receive e-mail using Internet providers such as CIX, Demon, Cityscape or UK Online does not necessarily mean you can run Navigator 3.0. To run the software, a dial-up SLIP or PPP account with TCP/IP stack, WINSOCK.DLL file and dialler package are required. If you are using an online service provider, these should all be supplied by your Internet provider.

The integration between Navigator 3.0 and your Internet account will depend largely on the individual service provider used. If you are already using a Netscape browser, Navigator 3.0 should simply swap-in. For completely new installations, both CompuServe and AOL are the easiest Internet providers to handle in terms of installation. Both companies have commercial business partnerships with Netscape.

With Netscape Navigator 3.0 installed lets examine some of the new multimedia features. As yet, there are few Web sites equipped to take advantage of all the features of the Web browser. As would be expected, Netscape has been quick to take full advantage of all the features of Navigator 3.0 on board its own site. However, there are numerous other Web sites primed to take advantage of many of the new features.

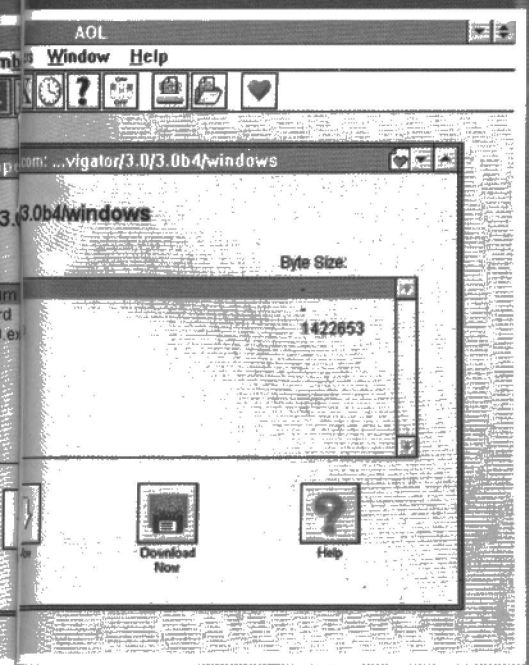


Photo 2. Two versions of Navigator 3.0 are available: minimum and standard.

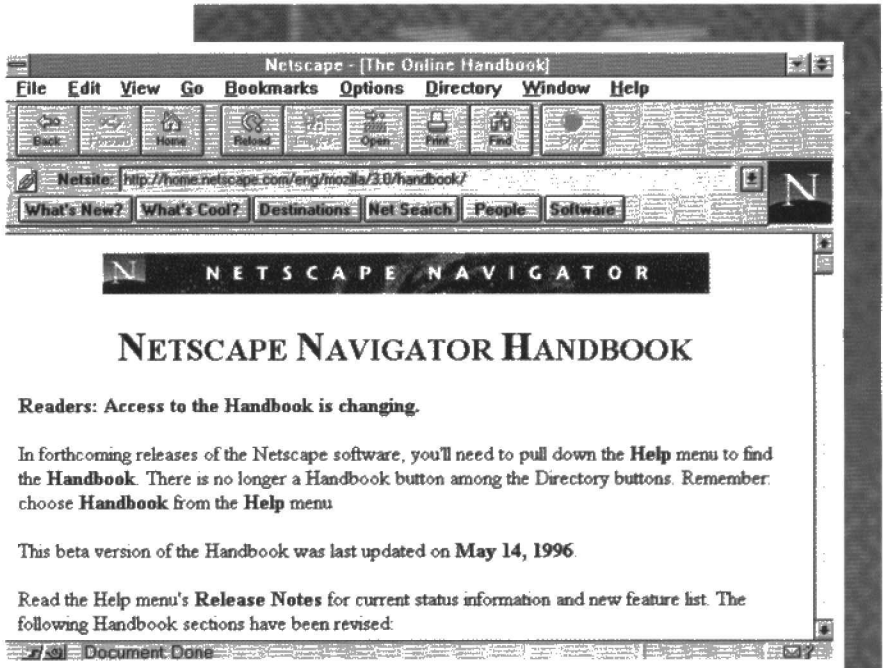
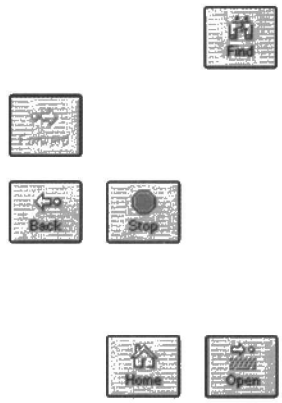


Photo 3. Web version of Navigator 3.0 manual.

Embedded Sound

LiveAudio enables users with PCs equipped with a sound card and speakers to listen to audio tracks, sound effects, music and voice directly from a Web page. Previously, sound files have had to be downloaded from Web pages to disk, and played using a proprietary sound player. Now, sound files are embedded with HTML code. As Web pages are downloaded, LiveAudio automatically identifies and plays standard sound formats – including AIFF, AU, MIDI and WAV – embedded or linked on a Web page. Sound files are played using a miniature console with play, pause, stop and volume controls, as shown in Photo 4.

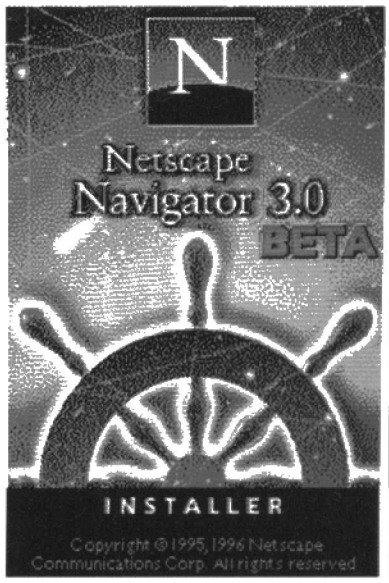


Moving Pictures

We've considered audio, but what about video? LiveVideo enables AVI video files to be viewed directly from a Web page, without downloading to disk, or using a proprietary video player. Video images embedded with a Web page can be viewed by double clicking on images. A complete menu of controls including Play, Pause, Rewind, Fast Forward, Frame Back, and Frame Forward can be accessed by clicking the right mouse button. This allows videos to be viewed on a frame-by-frame movement basis, as shown in Photo 5.

AVI is a standard video format, predominantly for the Windows environment, although proprietary AVI video readers are available for the Apple platform. Apple QuickTime is the most popular multimedia format on the Apple platform, combining both video and audio capabilities. Netscape has integrated the Apple QuickTime plug-in within Navigator 3.0, enabling both Apple and PC users to take advantage of Web pages containing Apple QuickTime files. Again, like with LiveAudio and LiveVideo, under Navigator 2.0, users would previously have had to use a proprietary pull-in, or download files to disk and use a helper application, such as MoviePlayer.

QuickTime enhanced Web pages look and feel different to pages that combine LiveAudio and LiveVideo. The reason for this is that they not only combine video and audio, but that they also contain



Navigator 3.0 beta logo.

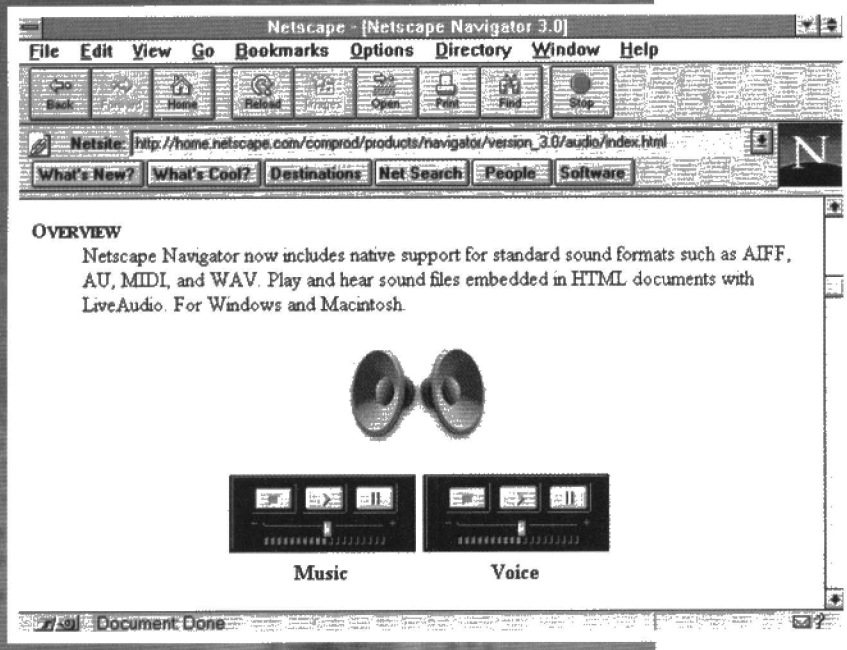


Photo 4. Loading and playing audio files directly from the Web page.

a 'fast start' feature. This feature presents the first frame of a movie file almost immediately, and will begin playing even before the movie has been completely downloaded. This is good news, since QuickTime movies tend to be very large (typically around 1M-byte) and take a considerable time to download, even with a high speed 28.8 modem.

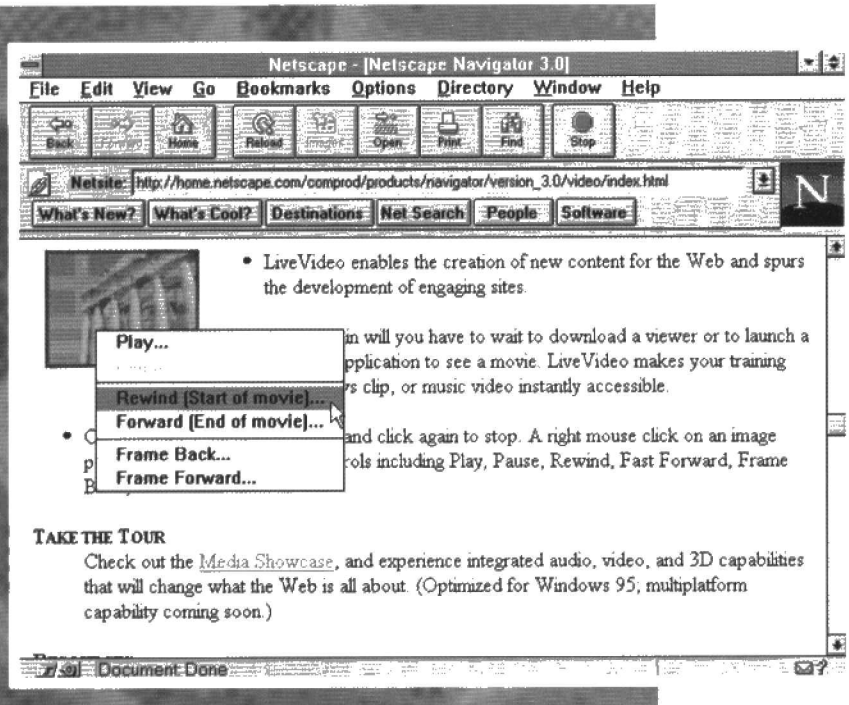


Photo 5. Videos can be viewed frame-by-frame basis, or as a moving sequence.

Virtual Reality

Netscape has stopped short of including Apple QuickTime VR, a 3D virtual reality movie environment, but QuickTime VR can be downloaded as a plug-in from the Apple Web site. Once loaded and installed as a component within Navigator 3.0, it allows QuickTime VR panoramas and objects embedded within a Web page to be viewed. This can either be done in real time, or offline after downloading enhanced QuickTime VR pages to disk. Do not rush to download the QuickTime VR component; very few Web pages include QuickTime VR content, which is presumably why Netscape have not included it as an integral part of Navigator 3.0.

More common is Netscape's own virtual reality environment called Live3D, based on the standard Virtual Reality Modelling Language (VRML). VRML, like HTML, is a cross-platform programming language. Consequently, unlike QuickTime VR, it works across Windows PC, Apple and UNIX. QuickTime VR was originally developed by Apple as a proprietary application, with Windows 3.1 and Windows '95 versions added later.

Live 3D enhanced pages, viewed with the VRML viewer integrated within Navigator 3.0, allow users to interact with text, images, animation, audio and video. One of the Live 3D demonstrations on the Netscape Web site at **http://home.netscape.com/comprod/products/navigator/live3d/index.html**, allows users to literally move around within a series a rotating logos, as shown in Photo 6. Selectable camera viewpoints, collision detection, and optional gravity add flexibility and realism to mouse navigation. Functions allowing the user to change viewpoints, perspective, navigation and detail are accessed using the right mouse button.

The Java Angle

Downloading audio and video and 3D files is not the only way to interact within the Navigator 3.0 environment. The browser can handle embedded blocks of Java code – know as Applets, directly from the Web page. Java is a programming language based on C++, developed by Sun. Java Applets embedded within a Web page enable two-way interaction between the user and the Web server, almost in the same manner that a user can run server based applications over a network. In this sense, an Applet is a mini-application embedded with a Web page. But what makes Java particularly unique, is the fact that it will run directly from an HTML document or Web page, across all platforms.

Netscape has included a trivial example of a Java-based Applet application at **http://home.netscape.com/comprod/products/navigator/version_3.0/developer/js-demo.html**. Here, users are able to use two Windows list boxes to select the colour and size of a Netscape polo shirt, as shown in Photo 7. Whenever a different combination of colour and size is selected, the two HTML-based list boxes call a JavaScript function and change the image displayed.

Using Java, audio and video, Web developers can create pages with live content that allow all three of the key technologies. Navigator 3.0 allows all three to be combined using a protocol format called LiveConnect. The theory is that LiveConnect allows any of the dozens of plug-ins, hundreds of Java Applets, and thousands of pages embedded with JavaScript to trigger any other plug-in, Applet, or JavaScript loaded on the page to run simultaneously or sequentially.

Needless to say, Netscape has yet to provide a convincing example, but the theory makes sense. With LiveConnect, clicking on an HTML button could cue separate video and audio files to play simultaneously, with the audio file providing a synchronised narration and score. Alternately, clicking on an HTML button could bring up an audio-only introduction, which in turn, could trigger a movie to run.

Internet Telephony

One of the features which has not yet been mentioned is CoolTalk. As shown in Photo 8, this application is discrete from Navigator 3.0, but is intended to run alongside the browser. Using a

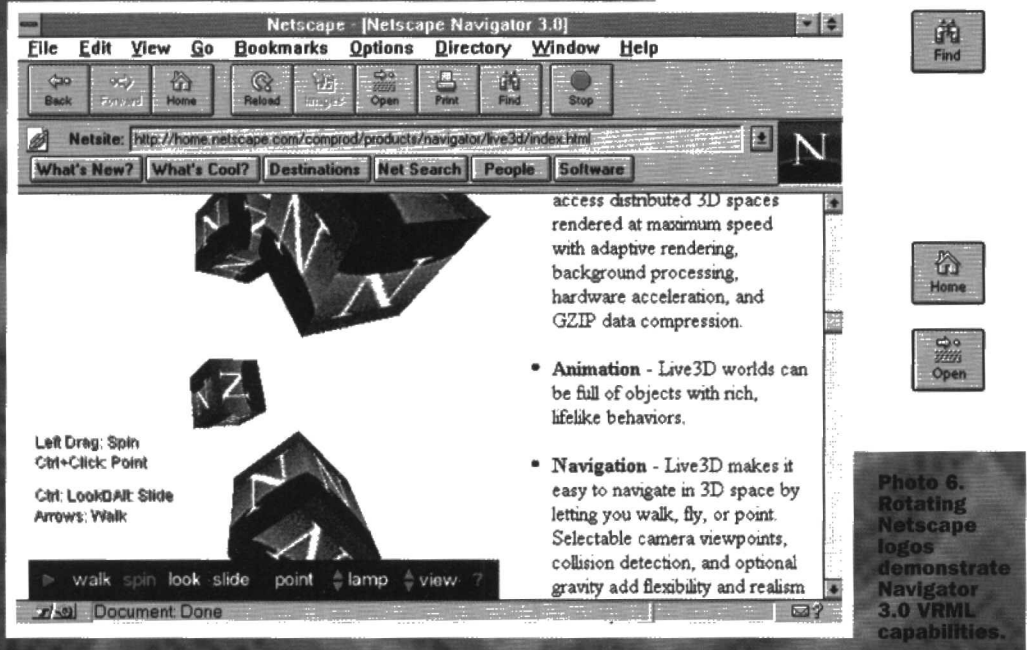


Photo 6. Rotating Netscape logos demonstrate Navigator 3.0 VRML capabilities.

Platform	Windows 3.1	Windows '95 and NT	Macintosh	Unix
Processor	386SX	386SX	68020	N/A
Minimum Memory (M-byte)	4	6	7	16
Recommended Memory (M-byte)	8	8	9	32
Minimum Installation Disk Space (M-byte)	3	9	6	15

Table 1. Netscape Navigator required platform specification.

sound card equipped with speakers and microphone, CoolTalk provides high-quality audio conferencing, a full-featured whiteboard, and text-based communications using the chat tool. Netscape reckon that CoolTalk will allow users to talk and work collaboratively with friends and colleagues anywhere in the world via the Internet. Key features of the software are highlighted in Table 2, and while we haven't got time to for an exhaustive review here, the software is neat, and it seems to work.

To establish an audio conversation over the Internet using CoolTalk, both users must simultaneously use Navigator 3.0 and CoolTalk. To raise a call, you send an e-mail, or voicemail to the individual you wish to contact. The recipient is notified of the caller via a dialogue box in Navigator or CoolTalk. A line is established by returning the voicemail or e-mail.

The good news is that the technology works. I managed to set up and hold a five minute telephone call between London and Boston on the East coast of the USA. The bad news is that the audio sounded like a very poor short wave channel with a half second satellite delay. There is also the paradoxical fact that I had to call ahead via the telephone to warn my friend in the US to turn his PC on and boot up Navigator with an Internet connection. Netscape's answer to this problem has been to include an answering machine within CoolTalk for users who are offline when called.

Security

Security is one of the other major areas which Netscape has addressed in Navigator 3.0. The new browser includes support for SSL 3.0 encoding and digital certificates. SSL uses authentication and encryption technology developed by RSA Data Security, based in the US. Netscape Navigator's export implementation of SSL uses a medium-grade, 40-bit key size for the RC4 stream encryption algorithm. The encryption established between your machine and a Web server remains valid over multiple connections, yet the effort expended to defeat the encryption of one message cannot be leveraged to defeat the next message.

A message encrypted with 40-bit RC4 takes, on average, 64 MIPS-years to break – a 64 MIPS computer needs a year of dedicated processor time to break the message's encryption. The high-grade, 128-bit US domestic version provides protection exponentially more vast. The effort required to break any given exchange of information is a formidable deterrent. Server authentication uses RSA public key cryptography in conjunction with ISO X.509 digital certificates.

Netscape Navigator and secure servers deliver server authentication using signed digital certificates issued by trusted third parties known as certificate authorities. A digital certificate verifies the connection between a server's public key and the server's identification (just as a driver's license verifies the connection between your photograph

Audio conferencing	**Shared Whiteboard**
Duplex sound so that you can speak and be heard simultaneously.	View and mark-up graphical images while online speaker to a colleague.
CoolTalk Phonebook	**Chat tool**
Web-based phonebook makes it easy to locate other CoolTalk users.	Text-based tool that enables you to send and receive typed messages, as well as entire text files.
Answering machine	
Records messages and caller information while you're not online.	

Table 2. Key features of CoolTalk.

NETSCAPE HISTORY

April 1994
'Mosaic Communications Corporation' founded by Jim Clark/Marc Andreessen.

August 1994
San Jose Mercury News selects Mosaic Communications products for online newspaper.

October 1994
Netscape Navigator beta released on the Internet, company becomes founding member of W3 consortium.

November 1994
Company changes name to Netscape Communications.

December 1994
Bank of America announces secure payment system with Netscape.

January 1995
Mastercard and Netscape announce relationship.

February 1995
Novell and Netscape sign strategic agreement.

March 1995
Navigator 1.1 beta released on Net.

April 1995
Netscape, AOL, CompuServe, Prodigy and IBM partner with Terisa for unified security approach.

May 1995
Netscape licences Sun's Java programming language.

June 1995
Netscape, Progressive Networks and Microsoft announce plan to lock out access to materials inappropriate for children.

July 1995
Netscape announces Secure Courier – a digital envelope for securing transactions on the Internet.

August 1995
Netscape goes public on Nasdaq.

November 1995
Netscape announces Navigator 2.0.

May 1996
Netscape announces beta version of Navigator 3.0.

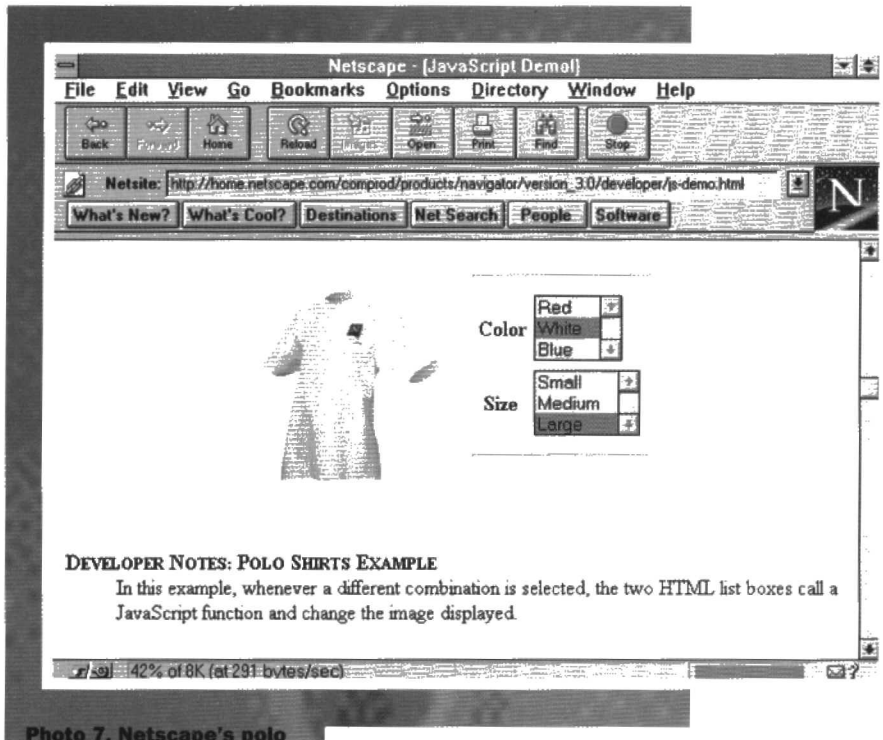


Photo 7. Netscape's polo shirt JavaApplet application.

and your personal identification. Cryptographic checks, using digital signatures, ensure that information within a certificate can be trusted.

When you attempt to log on to a secure server site, a digital certificate authorises you to access secure information. In the future, Netscape claim that digital certificates will replace the need for multiple passwords and user names, because authentication is automatic. Digital certificates will be issued to authorised individuals such as credit card holders, or bank customers wanting to manage their account online.

Conclusion

There is no doubt that Navigator 3.0 is a spectacular piece of software. The functionality of a version 3.0 enabled Web site completely sets it apart from the majority of existing sites. Until now, Web sites have been based on text and graphical images, similar in format to a printed page. Now there is no excuse for not having full multimedia, bringing audio and video to existing pages.

To prevent frustration, it is essential that Navigator 3.0 is used with as fast a modem as is possible. Using a 14.4 modem, it took over 4 minutes to load and run an 800k-byte video clip. Similarly, audio clips take several minutes to load. Netscape claim that a 14.4 modem is sufficient for Navigator 3.0 – they are correct, but you have to be very patient. If possible, use a 28.8 modem or faster.

If Netscape does not launch a commercial version of Navigator 3.0 before this article reaches print, remember that the software is still in beta. Inevitably, this means that it contains bugs, and is not completely stable. This is the price you pay for the privilege of trialling pre-production software. ELECTRONICS

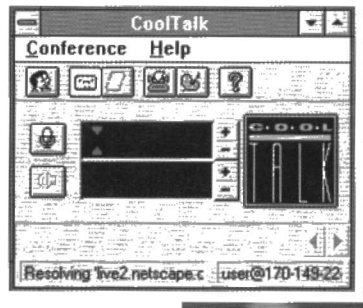


Photo 8. CoolTalk Internet Telephony.

@Internet

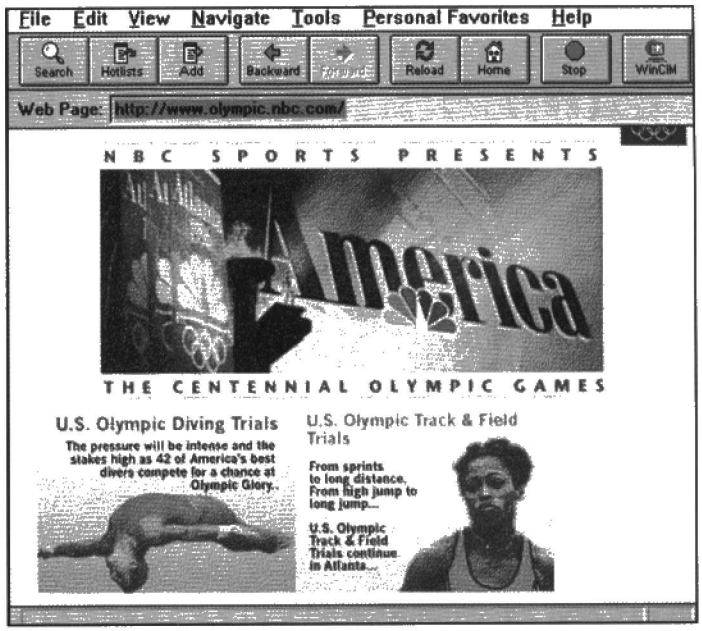
Ability to access the Internet is seen by all computer manufacturers as a selling point. How they go about providing Internet access is, however, in dispute.

Some manufacturers see Internet access as just another medium to add into their multimedia-capable computers. Certainly, if a consumer was to buy a multimedia machine, the extra few pounds required for Internet capability (to pay for a modem) at the time of purchase is only a tiny percentage of the computer's total.

On the other hand, some see cheapish Web browsers as the way forward – devices intended to sit on top of a television in the home. These browsers will access the Internet in the normal way, over a phone line or better, then display the received Web pages on the television screen. The other Internet services such as e-mail, ftp and gopher will be built in too. Limited computing ability will be included. The name coined for these Web browsers is network computers (NC). A large number of computer and software manufacturers have got together to create a worldwide standard for network computers. See Site Survey for further details.

The beauty about these network computers will be price. You don't need an all-singing-all-dancing computer complete with overgrown operating system (read 'expensive') to access the Internet. Any old (and cheap) computer can do it easily. Computer speed is not an issue – the weak link with Internet access is the communication line. Many network computers announced to date are planned around a 486 or equivalent microprocessor, which is more than adequate. Some manufacturers have been quoting prices of around £350 for such machines.

Mitac, the Taiwanese PC maker, sees a network computer as being nothing other than just a low-powered computer – neither fish nor fowl. Better, it thinks, to limit a browser to just Internet access. Then price could be really low. Mitac plans to release a Web browser at the end of the year, for a price less than £100.



Countdown to Atlanta

On April 6th, 1896, over 300 of the world's best athletes, representing 13 countries, gathered in Athens for the first modern Olympic games. One hundred years later, on July 19th, nearly 11,000 competitors from some 200 countries will gather in Atlanta for the 26th Summer Olympics. If you want to follow the games online, be sure to bookmark the following Olympic sites:

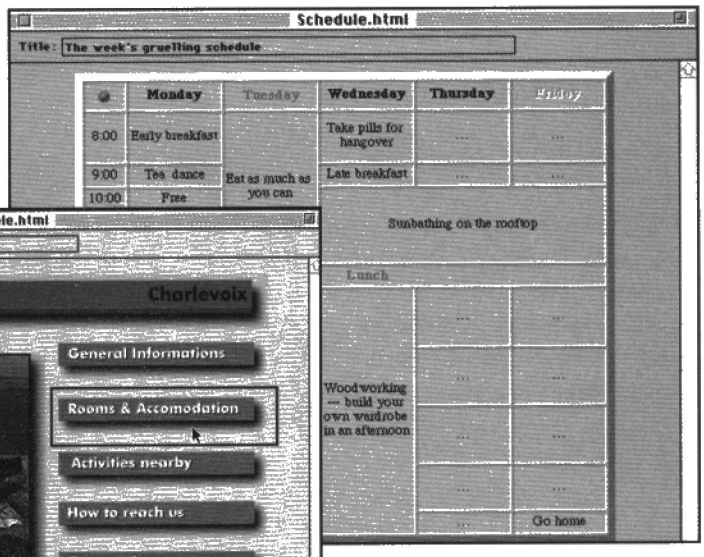
- The official 1996 Centennial Olympic Games World Wide Web Server at **http://www.atlanta.olympic**.org will offer near-real time scores, plus information on sports and venues, travel and tickets, official products, and more.
- NBC, which will broadcast the games, has a behind-the-scenes page at **http://www.olympic.nbc.com**, with an event competition schedule, and athlete profiles.
- The Atlanta Journal Constitution at **http://www.ajc.com** has its own page dedicated to the Atlanta Games at **http://www.atlantagames.com**.
- For information on the Special Olympics, visit the organisation's home page at **http://www.specialolympics.com**.

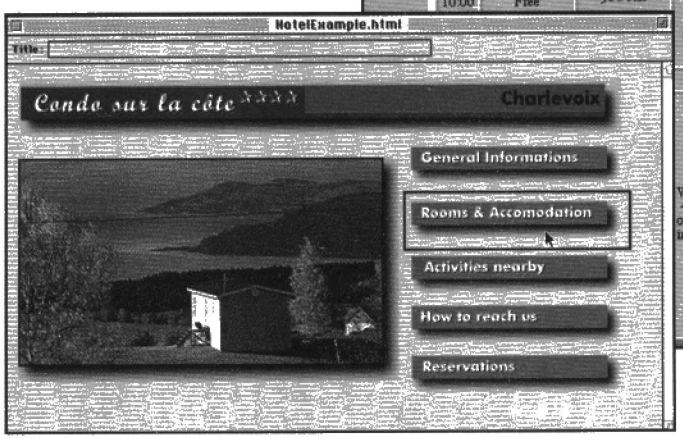
TableWorks

Anyone who creates Web pages will know the problems associated with tables. While most HTML editing programs (we've looked at quite a few over the last few months) do let you create them, they're not always as intuitive as modern software should be. However, there's shareware around which does the job far better than any commercial software we've yet seen.

TableWorks is the best example. It's an HTML editor program which can be used to create full Web page HTML documents, but it specialises in the production of tables, and that's where its beauty lies.

You can create quite plain, run-of-the-mill tables, in a somewhat similar way that you might in a modern Macintosh-based word processor. Cell and row dimensions can be dragged, text and other elements can be colourised, graphics can be imported into cells, borders and spacings can be altered, all with the typical ease of a well-formulated Mac program.





TableWorks really shines when you create tables with invisible borders, embed other tables within cells, and import multiple graphics. You can create complex and complete Web page layouts this way, very easily and speedily.

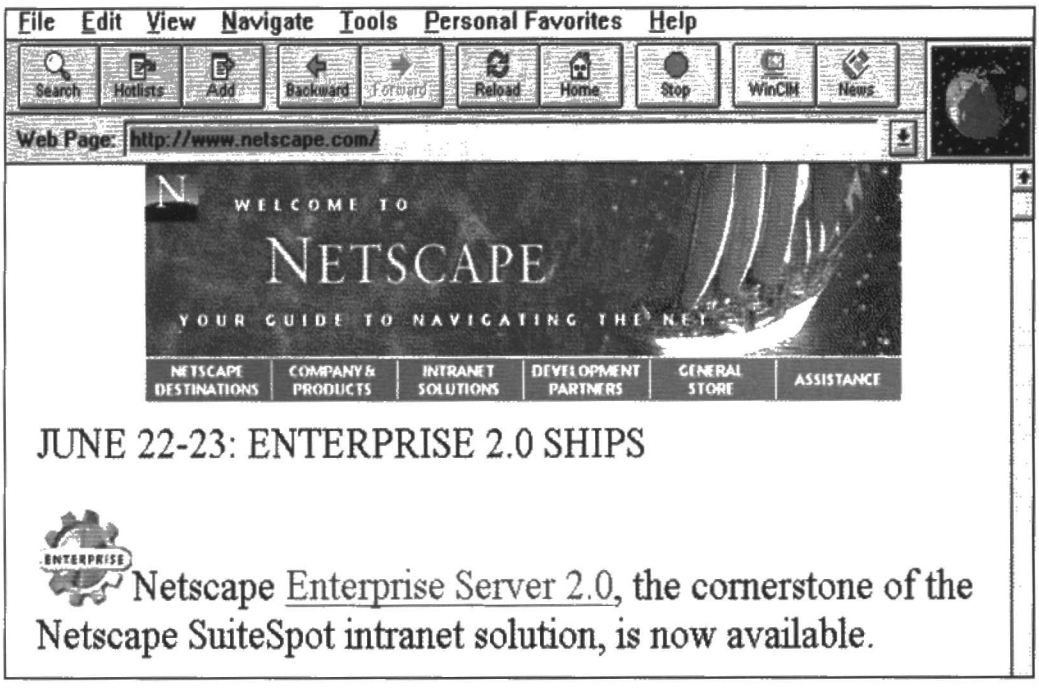
As you might guess, it's a Mac-only product, and you can download a demonstration program from **http://www.tableworks.com**. It's the sort of tool which Web page designers should keep up their sleeves.

Navigator Tops 38 Million Users

Netscape reckons it now has an installed base of more than 38 million users, making it the world's most popular personal computer application. Navigator has been shipping commercially for 18 months, and is the standard for communication over the Web, with an 84% market share.

Despite efforts by Microsoft to take away the share from Navigator, its popularity has been guaranteed by striking a wide variety of alliances with major players in the field, to assure that the software is built into virtually all new PCs. Netscape achieved a major victory several months ago, when Microsoft decided to license the Navigator.

Netscape also claimed this month that its Internet site at **http://www.netscape.com** now receives more than 80 million hits a day. It claims that the site has received more than 10 billion hits since its inception approximately two years ago, making it by far the most visited site on the Internet.



Passport for Web Access

Online service provider, CompuServe, has revealed a new technology which will allow its subscribers to carry a Virtual Passport for identification on the Internet. To be made available to all CompuServe members, Virtual Passport also allows users to access special fee-based Internet content areas without occurring charges.

CompuServe says Virtual Passport is an important, secure client/server technology for extending CompuServe's proprietary content into the open standards of Internet content and technology. When implemented, Virtual Passport's other benefits include the ability for Web sites to verify visitors to its site. For further details, check: **http://www.compuserve.com**.

Contact: CompuServe, Tel: (0800) 000400.

Site Survey

The month's destinations

See page 80 for this month's destinations

Bands Get Online with Webshop

Internet consultancy WebShop has just relaunched its Internet-based live music 'gig' directory, AudioWeb, at **http://www.webshop.co.uk/music**. The revamped system allows musicians to enter their gig details directly – and instantly – into its database, using an intuitive and easy-to-use Web-based menu system.

For bands all over the world, AudioWeb is the means to reach a totally new audience, as well as an existing fan base. AudioWeb has also been enhanced to allow site visitors the ability to search for a particular range of gigs, or simply browse.

Features of the AudioWeb guide include references to the venue, the band's name and the date of the gig. If the band or venue has a Web page or e-mail address, these can be included.

WebShop provide this service for free. Promoters, record companies and musicians are invited to submit their gig details to the database.

Contact: WebShop, Tel: (01702) 603557.

Wales uses Internet to attract Investment

Cardiff Bay is to be promoted to potential investors across the globe via the Internet, in an initiative which will also sell the Welsh capital's multi-media capabilities worldwide. Comprehensive information on the Bay and the city is contained on the site at: **http://www.cardiff-bay.co.uk**.

The Cardiff Bay Internet site has several objectives: to provide information on available development sites and grants to potential investors; to promote the amenities and attractions of the Bay to future residents and visitors; and to promote major markets.

@Internet

Complete Local Access Coverage for UK AOL Subscribers

AOL has opted for a national local call number to provide access to its network. AOL users can now dial (0845) 845 7444 to get local high speed access from anywhere in UK.

Jonathan Bulkeley, AOL UK's managing director, told *Electronics*, "It had always been our aim to provide our members on the UK mainland with 100% high speed local access to AOL, and by opting for the nationwide 0845 local rate number, we have exceeded our own expectations and spread our reach even further".

According to AOL, the introduction of the 0845 number does not affect UK subscribers already dialling local access numbers. However, for existing subscribers making long distance calls to get online and for people waiting for a local access number before subscribing, the new number will give immediate high speed, local call rate access.

Other beneficiaries of the new number include people who travel throughout the UK frequently or commute long distances between home to work, because they will no longer have to change their local POP number in their personal profile files to gain access to AOL at local call rates. For further details, check: **http://www.uk.aol.com**.

Contact: AOL, Tel: (0800) 279 1234.

Royals go online

At last, there's a place for royal watchers on the Web at **http://www.royalnetwork.com**. The Royal Network is a sort of virtual *Hello* magazine, detailing the latest gossip on the royal family.

Hot from the site, is the news that Hollywood players are chasing Fergie with their cheque books in a attempt to sign up her new book, while Playboy magazine is said to be offering $2 million for the Duchess to bare all. What an unpleasant thought.

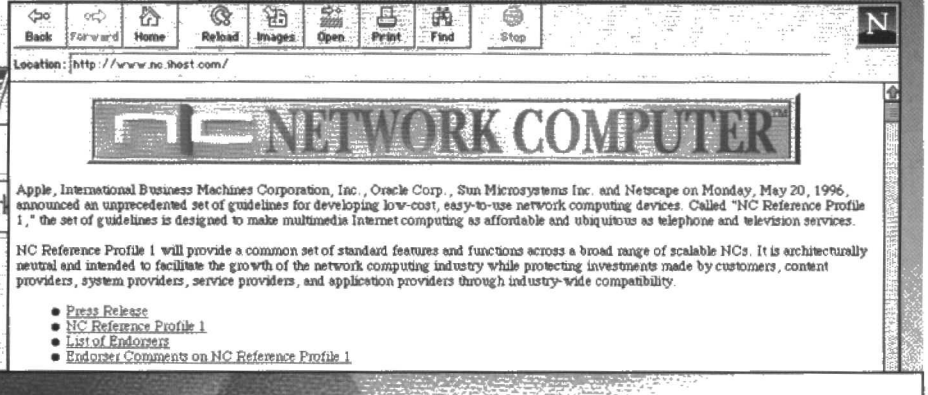
Site Survey

The month's destinations

For those unbelievers who think a Mac hasn't got the software for serious scientific and engineering work, take a look at the MacSciTech Users Association home page at **http://www.macscitech.org/mst.html#cal**, where you'll see thousands of hot-links to companies, software, examples and case studies of Macintosh use among the scientific and engineering community.

If you want to learn more about network computers, go to **http://www.nc.ihost.com/**, which is the network computer home page. Here, you can pick up hot-links to browse to, where you'll find exactly which computer manufacturers have endorsed the NC standard (known as reference profile 1 – there'll be further profiles as the NC concept evolves), and what it's all about.

Finally, for a bit of an oddball surf, check out Time Warner's *The Palace*, at: **http://www.thepalace.com/**. Download the free Palace 'shareware' (shouldn't this be freeware if it's free?), which lets you chat on-line with others at Palace sites cropping up around the Internet world. It's, err . . . interesting.

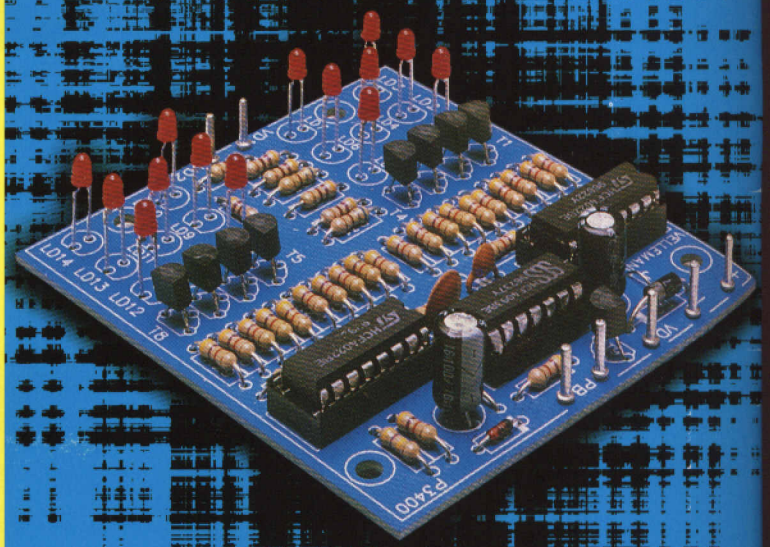


Above: MacSciTech Users Association home page.

Above Right: Network Computer's home page

Right: Time Warner's *The Palace*.

serious fun



The new Maplin MPS catalogue is *the* essential electronic buyers' guide. Featuring everything from cables, tools and test equipment to capacitors, switches and optoelectronic components. And now combining the entire Maplin and MPS product range under one cover, with volume price breaks, for the first time ever. With over 2,000 *new* products to choose from you won't want to miss our new catalogue. Reserve your copy now.

Who said science had to be dull? Not us! The new combined Maplin MPS catalogue is bursting with exciting ideas - from a huge range of electronics kits, cycle computers and navigation systems, to personal hi-fi, disco gear and home video editors. All at our best prices and with discounts for larger orders. Give your spare time a boost - reserve your copy of the new Maplin MPS catalogue now.

The new **Maplin MPS** catalogue is out September 1996, *reserve your copy now*

only £3.45 (free post & packing when you reserve your copy by 31 August)

Phone 01702 554 161
or visit your local Maplin store.

Also available from September at WH Smith and John Menzies.

MAPLIN

MAPLIN ELECTRONICS plc,
PO Box 3, Rayleigh, Essex SS6 8LR

MAPLIN – 35 locations throughout the UK

Barnsley (Wombwell), Belfast, Birmingham, Bradford, Brighton, Bristol, Cardiff, Chatham, Coventry, Dudley, Edinburgh, Glasgow, Leeds, Leicester, Liverpool, London (Edgware), London (Forest Hill), London (Hammersmith), London (Ilford), Manchester (Cheetham Hill), Manchester (Oxford Road), Middlesborough, Milton Keynes, Newcastle-Upon-Tyne, Northampton, Nottingham, Portsmouth, Preston, Reading, Sheffield, Slough, Southampton, Southend, Stockport, Stoke-on-Trent

MAPLIN MONDO SUPERSTORE now open at 3 Regent Street, **LEEDS**. Look out for new stores opening in your area soon!